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Commander
U S Army Engineer District Kansas City
ATTN CENWK PM E (Mr Bradley Eaton)
700 Federal Building
601 East 12th Street
Kansas City Missouri 64106 2896

Re Transmittal of Draft Baseline Human Health Risk Assessment
for the St Louis Army Ammunition Plant St Louis MO
Contract No DACW41 96 D 8014 Task Order No 0019

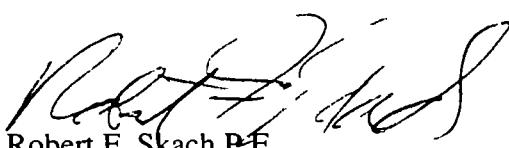
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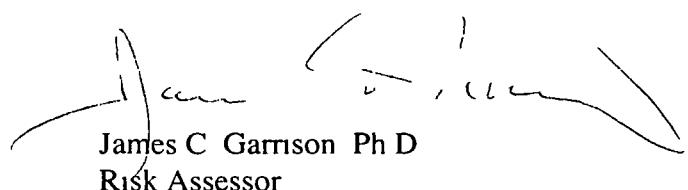
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Robert F Skach P.E.
Project Manager


James C Garrison Ph.D
Risk Assessor

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SUPERFUND DIVISION

URS Group Inc
10975 El Monte Suite 100
Overland Park KS 66211
Tel 913 344 1000
Fax 913 344 1011

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DRAFT BASELINE HUMAN HEALTH RISK ASSESSMENT**

**ST LOUIS ARMY AMMUNITION PLANT
ST LOUIS, MISSOURI**

**CONTRACT NO DACW41 96 D 8014
TASK ORDER NO 0019**

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**BASELINE HUMAN HEALTH RISK
ASSESSMENT
ST LOUIS ARMY AMMUNITION
PLANT
ST LOUIS, MISSOURI
CONTRACT NO DACW41-96-D-8014
TASK ORDER 0019**

Prepared for
Department of the Army
U S Army Engineer District
Kansas City District
Corps of Engineers
Kansas City Missouri

And
Department of the Army
Base Realignment and Closure
Atlanta Field Office
Ft McPherson Georgia

September 2003

URS

URS Group Inc
10975 EL MONTE SUITE 100
OVERLAND PARK KANSAS 66211

Job No 16529173

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List of Abbreviations, Acronyms, and Terms

bgs	below ground surface
BRAC	Base Realignment and Closure
CALM	Cleanup Levels for Missouri
CENWK	Kansas City District USACE
COPCs	Chemicals of Potential Concern
CTE	Central Tendency Exposure
EBS	Environmental Baseline Survey
FOST	Finding of Suitability to Transfer
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	Hazard Index
IEUBK	Integrated Exposure Uptake Biokinetic (model)
IRIS	Integrated Risk Information System
J&E	Johnson and Ettinger Vapor Intrusion Model
LOAEL	Lowest Observed Adverse Effect Level
MDNR	Missouri Department of Natural Resources
MDHSS	Missouri Department of Health and Senior Services
msl	mean sea level
NCEA	National Center for Environmental Assessment
NOAEL	No Observed Adverse Effect Level
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PRGs	Preliminary Remediation Goals
RAGS	Risk Assessment Guidance for Superfund
RfD	Reference Dose
RME	Reasonable Maximum Exposure
SAP	Sampling and Analysis Plan
SCEM	Site Conceptual Exposure Model
SF	Slope Factor
SLAAP	St Louis Army Ammunition Plant
SLOP	St Louis Ordnance Plant
SSEBS	Site Specific Environmental Baseline Survey

List of Abbreviations, Acronyms, and Terms

SVOCs	Semi volatile Organic Compounds
UCL	Upper Confidence Limit
URS	URS Group Inc
USACE	U S Army Corps of Engineers
USEPA	U S Environmental Protection Agency
VOC	Volatile Organic Compounds

This document provides a Baseline Human Health Risk Assessment (HHRA) for site related chemicals identified in various environmental media at the St Louis Army Ammunition Plant (SLAAP) located in St Louis Missouri. The methodologies used in performing this risk assessment are consistent with guidelines established by the U S Environmental Protection Agency (USEPA) in Risk Assessment Guidance for Superfund (RAGS) (USEPA 1989a) and the Missouri Department of Natural Resources (MDNR) in Cleanup Levels for Missouri (CALM) (MDNR 2001). This HHRA was prepared on behalf of the U S Army Corps of Engineers (USACE) Kansas City District (CENWK) and Base Realignment and Closure (BRAC) Headquarters under URS Group Inc (URS) Contract number DACW41 96-D 8014 Task Order 0019.

The St Louis Ordnance Plant (SLOP) was constructed in 1941 as a 276 acre small arms ordnance plant that produced 30 and 50 caliber munitions. In 1944 21 05 acres in the northeast portion of SLOP were converted from small arms munitions production to 105 mm Howitzer shell production and this portion was designated as SLAAP. Additional land was acquired on the north side of SLOP. Currently the SLAAP property contains seven unoccupied buildings that were used to house SLAAP's main operating processes.

Previous investigations demonstrated the presence of a number of chemicals in soil and groundwater at the Site. This HHRA evaluated potential risks and hazards for soils and groundwater in support of the Finding of Suitability to Transfer (FOST) process. Contaminants in shallow soils (0 0 5 feet bgs) combined surface and subsurface soils (0 10 feet bgs) and groundwater were characterized as part of the Site Specific Environmental Baseline Survey (SSEBS). These data were screened against risk based screening values including both the Preliminary Remediation Goals (PRGs USEPA 2002a) and CALM screening values (MDNR 2001) to identify the Chemicals of Potential Concern (COPCs) for quantitative evaluation in the HHRA.

At the present time a number of buildings are present at SLAAP and one building that was present at the beginning of this investigation (Building 3) has since been removed. The fate of the remaining buildings is currently unknown. To address the uncertainty of which buildings may or may not remain the risk assessment evaluated soils under each building railroad roadway and the Northeast parking area as separate exposure areas. In the event that any existing Site features were demolished this provides the information necessary to address the risks associated with newly exposed soils. This approach also addresses the fact that different industrial activities occurred in different buildings former buildings or other Site areas and that different chemicals and chemical concentrations are found in each of these. In addition risks and hazard indices were calculated for numerous hotspots across the Site as well as on a Site wide basis.

Several different land use scenarios were evaluated in the HHRA in order to allow Site decision-makers to make informed decisions about future uses of the property. Alternative scenarios evaluated included trespassers commercial/industrial workers and hypothetical future residents potentially exposed to surface soils (0 0 5 feet bgs) and excavation/construction workers exposed to deeper soils (0 10 feet bgs). Cancer risks and hazard indices were calculated for each of these scenarios under both Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) conditions.

For soils at most areas of the Site and for Site wide groundwater the RME cancer risks were within or below the target risk range of 10^{-4} to 10^{-6} identified in the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA 1990) and most hazard indices were below the threshold of 1. The CTE cancer risks and hazard indices were even lower.

Areas found to exceed a cancer risk of 10^{-4} or hazard index of 1 are listed below:

- Building 2 An RME hazard index of 3 was calculated for a hypothetical future resident Aroclor 1248¹ was the primary contributor to this elevated hazard index. The CTE hazard index for this receptor was 0.4.
- Building 5 An RME hazard index of 6 and a cancer risk of 2×10^{-4} was calculated for a hypothetical future resident. The CTE hazard index was 1 and the CTE cancer risk was 2×10^{-5} . The pesticide DDT was the primary contributor to the hazard index. DDT and benzo(a)pyrene were the primary contributors to the cancer risks. In addition lead was found in surface soils at a 95% UCL of 333 mg/kg which is above the IEUBK-based residential action level of 260 mg/kg used by MDNR.
- Hotspot 2 This Hotspot covers the majority of the Building 2 footprint. An RME hazard index of 2 was calculated for a residential scenario. The CTE hazard index was 0.4. Aroclor 1248 was the primary contributor to this hazard index.
- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint. RME cancer risks were 1×10^{-3} for residents and 3×10^{-4} for industrial/commercial workers. CTE cancer risks were 4×10^{-4} for residents and 2×10^{-5} for industrial/commercial workers. RME Hazard indices were 33 for residents and 3 for industrial/commercial workers. CTE Hazard indices were 15 for residents and 1 for industrial/commercial workers. DDT was the primary contributor to the hazard index. DDT and Aroclor 1248 were the primary contributors to the cancer risks.
- Site wide soils Site wide risks and hazards were calculated by combining soil samples from across the entire Site. The RME hazard index was 6 for the residential scenario and the CTE hazard index was 1. The primary contributors to the elevated hazard index were Aroclor 1248, Aroclor 1254, and DDT. It is important to note that while these risks are defined as Site wide the distribution of these chemicals is relatively limited to a few portions of the Site.

¹ The term PCB 1248 and Aroclor 1248 are synonymous terms as are PCB 1254 and Aroclor 1254.

This document provides a Human Health Risk Assessment (HHRA) for site related chemicals identified in various media at the St Louis Army Ammunition Plant (SLAAP) located in St Louis Missouri Previous investigations have indicated the presence of a number of chemicals in soil and groundwater at the Site The primary goal of this HHRA is to address whether these chemicals pose a potential health threat to current and reasonably anticipated future receptor populations

This document was prepared on behalf of the U S Army Corps of Engineers (USACE) Kansas City District (CENWK) and Base Realignment and Closure (BRAC) Headquarters under URS Group Inc (URS) Contract number DACW41 96 D 8014 Task Order 0019

The U S Army has designated the SLAAP property for transfer The results of this risk assessment will be used to support the property transfer consistent with the Finding of Suitability to Transfer (FOST) process in accordance with American Society for Testing and Materials (ASTM) Method D 6008-96 Standard of Practice for Environmental Baseline Surveys and ASTM Method E 1527-97 Standard Practice for Environmental Site Assessments Phase I Environmental Site Assessment Process (ASTM 1996) The FOST process determines that a real property is environmentally suitable for transfer because

- The property has never been contaminated (i e no release or disposal of hazardous substances or petroleum products has occurred) or
- The property has been contaminated but is still suitable for transfer because
 - environmental remedial actions have been taken to protect human health and the environment consistent with the property's intended use or
 - the contamination is present at levels that do not represent a threat to human health and the environment consistent with the intended use

The technical approaches and assumptions used in this risk assessment are based on information presented in the Site Specific Environmental Baseline Survey (SSEBS) Sampling and Analysis Plan (URS 2002) and technical scoping discussions among the Missouri Department of Health and Senior Services (MDHSS) Missouri Department of Natural Resources (MDNR) USACE and URS The methodologies used in performing this risk assessment are consistent with guidelines established by the U S Environmental Protection Agency (USEPA) in Risk Assessment Guidance for Superfund (RAGS) (USEPA 1989a) and the MDNR in Cleanup Levels for Missouri (CALM) (MDNR 2001) The risk assessment was conducted using the steps listed below and detailed in following sections

- Site Description/Background Information
- Identification of Chemicals of Potential Concern
- Exposure Assessment
- Toxicity Assessment
- Risk Characterization
- Uncertainty Analysis

In addition risk calculation spreadsheets are presented in **Attachment A** and detailed evaluation of data is presented in **Attachment B**

17 acre 11 SITE DESCRIPTION

The SLAAP property (Site) is an approximately 21-acre site that is located in an urban mixed-use (commercial industrial and residential) neighborhood adjacent to Interstate 70 in St Louis Missouri. The Site is bounded on the north by Interstate 70 (I-70), on the west by Goodfellow Boulevard, on the south by PURO Chemical Division (PURO) and the east by Riverview Boulevard. Commercial and industrial properties directly border the Site. The nearest residential neighborhoods are located behind commercial properties on the west side of Goodfellow Boulevard and across I-70 to the north.

The Site has been vacant since 1998. The SLAAP property contains seven unoccupied buildings. Except for small grassy areas buildings and asphalt cover the SLAAP property. A railroad spur that once served the former Building 202 ABC (renumbered as Building 3) remains near the middle of the property. Building 3 was recently demolished as part of a polychlorinated biphenyl (PCB) remediation effort (Arrowhead Contracting 2003). A security fence encompasses the Site. The general layout of the Site is shown in **Figure 1 1**.

12 SITE HISTORY

The St Louis Ordnance Plant (SLOP) was constructed in 1941 as a 276 acre small arms ordnance plant that produced 30 and 50 caliber munitions. In 1944 21 05 acres in the northeast portion of SLOP were converted from small arms munitions production to 105 mm Howitzer shell production and this portion was designated as SLAAP. Additional land was acquired on the north side of SLOP. Currently the SLAAP property contains seven unoccupied buildings that were used to house SLAAP's main operating processes.

After World War II SLAAP was placed on standby status. It was reactivated from November 1951 to December 1954 and again from November 1966 to December 1969 to support 105 mm Howitzer shell production. The plant was maintained and operated by the Chevrolet Shell Division of General Motors from 1951 until 1958 by the U.S. Defense Corporation from 1958 to 1966 and by the Chevrolet Motor Division of General Motors from 1966 until 1972 when Donovan Construction Company was awarded the maintenance and surveillance contract.

In 1984 buildings at SLAAP were renovated to house filing and administrative operations by more than 500 personnel from the U.S. Army Aviation Systems Command. From 1986 to 1990 SLAAP was under the command of the U.S. Army Armament Munitions and Chemical Command. In 1989 the Department of the Army determined that SLAAP was no longer required to support its munitions mission and most industrial equipment was removed from the plant. In 1990 plant ownership and control were placed under the U.S. Army Aviation and Troop Command. As of 1993 SLAAP maintenance and surveillance activities were being subcontracted by Donovan Construction Company to Plant Facilities and Engineering Inc. From 1998 to the spring of 2003 SLAAP was vacant and under the control of U.S. Army Aviation and Missile Command. The Army BRAC program assumed responsibility for the Site in the spring of 2003.

13 SITE GEOLOGY

The geology of the SLAAP property based on the Comprehensive EBS Report (TTEMI 2000) and initial and Contingency Sampling Program field investigations for the SSEBS generally consists of fill materials lean clay (silty clay) fat clay and cherty gravel overlying Pennsylvanian age shale Underlying the shale is the Mississippian age St Genevieve limestone

Fill material consisting of a thin layer of gravel (typically one foot thick) is usually present underneath asphalt and concrete In addition fill material consisting of lean clay is encountered throughout the Site generally ranging in thickness from 1 to 8 feet However since the fill material was likely cut from adjacent lean clay portions of the Site the interface is not clear and the true depth of the fill may be significantly deeper in some portions of the Site than described on the boring logs Underlying the fill material is lean clay and in most of the borings fat clay is underlying the lean clay The thickness of the fill/lean clay/fat clay overburden materials overlying the shale range from approximately 14 to 26 feet

Shale was encountered in ten of the thirteen monitoring well borings and twelve soil borings completed during the Comprehensive EBS and SSEBS investigations at depths ranging from 12 to 31 9 feet bgs The maximum thickness of shale encountered was 15 feet however all of these borings were terminated prior to reaching the bottom of the shale unit According to the Comprehensive EBS a soil boring drilled in 1971 at SLAAP encountered a medium hard medium- to fine grained limestone (St Genevieve limestone) at 65 feet and the bedrock units beneath the Site were reported as flat lying (TTEMI 2000)

14 SITE HYDROGEOLOGY

Bedrock units in and around St Louis are capable of yielding varying amounts of groundwater Well yield depends on site specific geologic and well characteristics Most wells in the St Louis area yield a maximum of 50 gallons per minute from depths down to 800 feet bgs (USATHMA 1979) These wells are screened in limestones and sandstones ranging in age from Mississippian to Ordovician Water yields of up to 1 955 gallons per minute (gpm) can be expected from wells drilled in thick alluvial deposits that contain little silt or clay like material However no potable water wells are reported to exist within 3 miles down gradient of SLAAP (USAEEHA 1993)

No surface water is present on the SLAAP property The closest body of water the Mississippi River is located about 3 miles from the property Stormwater on the property is collected by catch basins that discharge to the Metropolitan St Louis Sewer District combined sewer system

Regional groundwater flow in the SLAAP area is north northeast toward the Mississippi River The stormwater runoff in St Louis County discharges to the Missouri River to the north the Mississippi River to the east and the Meramec River to the south

15 EXPOSURE AREAS EVALUATED IN THE HHRA

At the present time a number of buildings are present at SLAAP Building 3 has been recently demolished and the contaminated soils have been removed (Arrowhead Contracting 2003) The fate of the remaining buildings is unknown To address this uncertainty the risk assessment has evaluated soils under buildings (and former buildings) separately as individual exposure areas Specifically this approach

- Provides an evaluation of potential risks should one or more buildings be removed and
- Addresses the fact that different industrial activities occurred in different buildings and that each building contains specific chemicals and chemical concentrations related to those past activities

In addition to calculating risks for the individual building exposure areas the risk assessment also evaluated potential risks based on

- Site wide soil data
- Hotspot soil data and
- Site wide groundwater data

A detailed discussion of the individual exposure areas evaluated in the HHRA is presented in **Section 3.3**

The first step in the risk assessment process is the identification of the Chemicals of Potential Concern (COPCs) to be considered for the estimation of potential risks. The COPCs are a subset of all of the chemicals detected at the Site representing those chemicals that have the greatest potential to pose risks for the Site. By careful screening of Site data the risk assessment can limit the chemicals undergoing a full evaluation without underestimating overall Site risks.

Site related risks were determined for individual exposure areas for soils (i.e. on an area by area basis) and on a site wide basis for groundwater. Because of this COPCs differed from one area to another and between different media.

2.1 IDENTIFICATION OF SOIL COPCs

Previous soil sampling indicated the presence of a limited number of chemicals at the Site. Soil COPCs were developed independently for each exposure area. Soil analytical results from each exposure area were compared with risk based screening criteria specifically USEPA Region IX Preliminary Remediation Goals (PRGs) for Residential Soil (USEPA 2002a) and MDNR Cleanup Levels for Missouri (CALM) residential soil (Scenario A) values (MDNR 2001). Any chemical with a detected concentration exceeding either screening value was retained as a COPC for soil in that exposure area. Chemicals with no detected concentrations in an exposure area were not considered COPCs.

For purposes of evaluating potential exposure to surface and subsurface soils by different receptor populations soil COPCs were separated into two groups. Potential exposures to surface soils were based on soil analytical data collected from 0 to 6 inches bgs. Because the deepest trench that a future excavation worker is reasonably expected to dig is about 10 feet bgs, exposures to subsurface soils were based on soil analytical data collected from 0 to 10 feet bgs.

Summaries of analytical data for soil sampling results in each exposure area with comparison to screening criteria and selection of COPCs are presented in **Attachment B**.

2.2 IDENTIFICATION OF GROUNDWATER COPCs

As noted previously groundwater in the vicinity of the Site is not used as a drinking water source. The only potential direct exposure to groundwater is if a Future Excavation Worker were to trench into areas containing shallow groundwater (i.e. 0 to 10 ft bgs). Groundwater analytical results were compared with PRGs for Tap Water (USEPA 2002a) and CALM groundwater target concentrations (MDNR 2001). Any chemicals found in shallow groundwater above the groundwater screening values were retained as COPCs for the purpose of evaluating direct exposure.

In addition to direct contact there is the potential for inhalation of volatile contaminants (i.e. volatile organic compounds (VOCs)) released from groundwater. This could include areas where the depth to groundwater is greater than the depth of excavation (i.e. >10 feet bgs). VOCs found to be present in the uppermost groundwater unit at concentrations exceeding their respective screening concentrations were retained as COPCs even when groundwater is located greater than 10 ft bgs. For this risk assessment a volatile contaminant was defined as a contaminant having both a molecular weight less than 200 and a Henry's Law Constant greater than 10^5 atm m³/mole (USEPA 1991a).

2.3 TREATMENT OF CHEMICALS DETECTED IN BACKGROUND SAMPLES

Some compounds were present at the Site in exceedance of the screening criteria due to naturally occurring background conditions or non site related anthropogenic activities. These include metals and essential nutrients present in soil throughout the entire geological area surrounding the Site. Additionally along the railroad these included the same metals and essential nutrients along with semi volatile organic compounds (SVOCs) typically associated with normal railroad operations (i.e. railroad tie preservatives and releases from diesel engines) that may be unrelated to Site impacts. USEPA has recently developed guidance for addressing risks associated with background chemicals (USEPA 2002b). Consistent with this guidance the risk assessment evaluated background as follows:

- For inorganic chemicals such as arsenic Site levels were compared to both risk based screening levels and local background
 - If the concentrations were within the local background range and below the risk based screening levels they were excluded from further evaluation in the risk assessment
 - If the concentrations were within the local background range but exceeded the risk based screening levels they were identified as COPCs. COPCs in this category were not evaluated quantitatively in the risk assessment but were discussed in the uncertainty analysis
 - If the concentrations exceeded the local background range but were below the risk-based screening levels they were excluded from further evaluation in the risk assessment
 - If the concentrations exceeded the local background range and the risk-based screening levels they were retained as COPCs for quantitative evaluation in the risk assessment
- All organic chemicals are assumed to be of anthropogenic origin (i.e. not naturally occurring)
 - If the maximum concentrations were below the risk based screening levels they were excluded from further evaluation in the risk assessment
 - If the concentrations were above the risk based screening levels they were retained as COPCs for quantitative evaluation in the risk assessment
 - Several background locations were selected along the railroad in order to differentiate those chemicals that were related to normal railroad operations from those that were related to industrial activities at SLAAP. This sampling focused on a subgroup of SVOCs the polynuclear aromatic hydrocarbons (PAHs) typically associated with railroads. Risks associated with these background chemicals were evaluated quantitatively in the risk assessment. The risk assessment discusses the overall risks associated with railroad areas on the SLAAP property as well as the relative contribution from non site specific and site specific sources

The purpose of the exposure assessment is to estimate the magnitude of potential chemical exposure among various receptor populations. The steps required to perform an exposure assessment include the following:

- Identification of potential receptor populations
- Evaluation of potential exposure pathways for completeness
- Evaluation of exposure parameters
- Estimation of exposure point concentrations

The approach used in this HHRA was to incorporate conservative exposure assumptions when estimating the magnitude of potential exposures so that potential risks posed by the Site were not underestimated. At the same time exposure scenarios that were considered unlikely were excluded since they do not reflect realistic exposure conditions. Scenarios and exposure assumptions used in this HHRA were previously submitted and approved in the SSEBS Sampling and Analysis Plan (SAP) (URS 2002).

In this risk assessment exposure is defined for both central tendency exposure (CTE) and reasonable maximum exposure (RME) conditions. The RME is meant to represent the maximum exposure for an individual in a population that could reasonably be encountered. The CTE represents the exposure for an individual under average conditions.

3.1 IDENTIFICATION OF POTENTIAL RECEPTOR POPULATIONS

A receptor population is identified as an individual or group of individuals that may potentially be exposed to Site related chemicals. The potential receptor populations may include both present and hypothetical future populations. Because land use conditions vary by exposure area potential receptor populations may vary by area. Potential receptor populations for the SLAAP property and their definitions are summarized below:

- **Current Trespasser/Site Visitor** Current trespassers or sporadic visitors to the Site property
- **Future Industrial/Commercial Worker** Hypothetical future employees of potential industrial or commercial properties on the Site. The Future Industrial/Commercial Worker is assumed to work outside performing non intrusive duties (i.e. not involved in soil excavation)
- **Future Excavation/Construction Worker** Hypothetical future employees or contractors who perform soil excavation duties (e.g. utility installation/repair foundation construction) in which they are potentially exposed to contamination in subsurface soil and shallow groundwater
- **Future Resident** Hypothetical future residents who may live on the Site in the unlikely event that it is converted to a residential property

While these four exposure scenarios do not represent every potential receptor population that could conceivably exist at SLAAP they are considered the most conservative (i.e. high-end exposure) populations that are likely to be encountered at the Site. Although other receptor

populations may potentially be present at the Site exposure to Site related contaminants by these populations is likely to be more sporadic and involve less intensive contact

3.2 EVALUATION OF POTENTIAL EXPOSURE PATHWAYS

An exposure pathway is a mechanism by which a receptor may come into contact with a chemical. Once exposure occurs the potential exists for the chemical to pose a health risk to the receptor. An exposure pathway consists of the following four necessary elements as defined in RAGS (USEPA 1989a)

- a chemical source and a mechanism of chemical release
- a medium of transport for the chemical
- an exposure point at which the receptor may make contact with the chemical
- an exposure route through which chemical uptake by the receptor may occur

The evaluation of potential exposure pathways for completeness of the four elements is critical. Each of these four elements must be present for an exposure pathway to be complete. The absence of any one of these elements results in an incomplete exposure pathway. Health risks do not exist in an incomplete exposure pathway. Only potentially complete pathways are addressed in the risk assessment.

Figure 3.1 presents a site conceptual exposure model (SCEM) for the SLAAP facility. This figure is a visual depiction of potential exposure pathways and the sources and mechanisms by which each receptor population might be exposed. Potentially complete and significant exposure pathways are indicated with solid lines.

Exposure scenarios are developed based on current uses of the Site as well as potential future uses. Given that the Site is not an active facility at this time and that access is controlled by security fencing, current exposure is likely to be restricted to occasional Site visitors and trespassers. The most likely future property use at SLAAP is assumed to be industrial or commercial. Excavation work associated with future building construction, utility installation and maintenance etc is likely. Residential development is considered to be unlikely for all portions of the Site for the foreseeable future. However because many of the properties surrounding the Site are residential and in order to be able to evaluate whether the property can be transferred without restriction this hypothetical future land use was evaluated in the HHRA.

Groundwater is not used at the Site for either drinking water or industrial purposes. Groundwater is not used as a drinking water source in the City of St Louis. Additionally the City of St Louis has established Ordinance 13 272 (City of St Louis 1885) that prohibits the installation of drinking water wells within the city limits indicating that Site groundwater will not be used as a source of drinking water. Thus groundwater was not evaluated as a drinking water source for current or future receptors in the HHRA. Incidental exposure to shallow groundwater could occur via excavation activities and releases of VOCs from groundwater could result in exposure to individuals in excavation trenches or inside buildings. These pathways are evaluated in the HHRA.

Given the current conditions and anticipated future use of the facility the following receptor populations were evaluated in the HHRA:

- **Current Trespasser/Site Visitor** Currently most areas of the Site are covered by buildings or paved. Trespassers or visitors could contact contaminated soils around the periphery of the property in areas of exposed surface soil. Exposure could occur via direct dermal contact or incidental ingestion of soil or inhalation of dust. The inhalation exposure route is considered insignificant relative to the other two routes since exposed soils are vegetated and thus unlikely to generate substantial amounts of dust. The HHRA quantitatively evaluated direct dermal contact and incidental ingestion of exposed surface soils by current trespassers/visitors. A future trespasser/visitor scenario was not quantitatively evaluated in the HHRA since more conservative (e.g. health protective) future use scenarios were evaluated.

In addition to soil exposure, current trespassers could also be exposed to contaminants in buildings at SLAAP. As described below, building exposures cannot be adequately addressed using USEPA's risk assessment process as described in RAGS (USEPA 1989a).

- **Future Industrial/Commercial Worker** Given that the most likely future use of the Site is as a commercial/industrial facility, the future worker scenario is considered the most realistic future scenario for the facility. In contrast to the trespasser exposure by workers could occur anywhere on Site including areas that are currently paved or covered with buildings since it is likely that some or all of the buildings currently on site will be removed in the future. For purposes of the HHRA, workers could be considered anybody who works at the Site on a daily basis for an extended period of time (years). Industrial/commercial workers could be exposed to surface soils via direct dermal contact, incidental ingestion and inhalation. As was true for the trespasser, inhalation of dust was considered minor/insignificant and was not evaluated quantitatively.
- **Future Excavation/Construction Worker** Construction workers, utility workers and other excavation workers could be exposed to both surface and subsurface contamination during any type of excavation work. Exposure could occur from direct dermal contact and incidental ingestion of soils or groundwater (where groundwater is present at depths less than 10 ft bgs) as well as inhalation of VOCs released from these soils or from the underlying groundwater. For purposes of the HHRA, excavation work was evaluated for soils ranging from 0-10 ft bgs, consistent with the deepest routine depth anticipated for utility lines.
- **Hypothetical Future Resident** Although residential use of the property is unlikely, a hypothetical resident was evaluated for potential exposure to surface soil using the same exposure routes (direct dermal contact and incidental ingestion) as used for the industrial/commercial worker. Residential scenarios are generally considered the most conservative scenarios evaluated in a HHRA, thus the inclusion of this scenario in the HHRA should provide a conservative (health-protective) estimate of potential risks for other populations that may be present on site but that were not evaluated quantitatively.

Residential exposure to groundwater via ingestion is not currently considered likely since it is illegal to construct a domestic supply well within the city of St. Louis. Additionally, groundwater contamination was fully characterized as part of the SSEBS (URS 2003). Limited perched and turbid groundwater was found on site. In addition, monitoring wells had yields that were very poor. It is unlikely that on-site groundwater would be usable as a domestic water supply. Based on this, the HHRA did not quantitatively evaluate groundwater as a potential drinking water source.

It should be noted that this risk assessment does not provide a quantitative evaluation for ecological risks associated with the Site. The limited area of the Site not covered by buildings or pavement offers minimal habitat of poor quality (i.e. mowed lot) and there are no surface water bodies present at the Site. As identified by MDNR (1993) there are no endangered species in the vicinity of the Site. Ecological risks associated with the Site are assumed to be negligible.

Several buildings currently on site are likely to contain some level of contamination. Current risk assessment protocols cannot accurately estimate risks associated with chemicals on the walls and floors of buildings. The potential acceptability of contamination in the building related materials are evaluated based on comparisons to standards for lead, asbestos and PCBs. A discussion of potential human exposure to contaminated building material as described above is included in this HHRA (**Section 5.2.14**). From a risk perspective it should be noted that the buildings are not occupied at this time nor are they likely to be occupied in the future without requiring substantial renovation first. Such renovation (e.g. cleaning, painting, wall partitions, new flooring, active ventilation system, etc.) would undoubtedly reduce or eliminate potential exposure to any residuals on the building materials.

3.3 EXPOSURE AREAS

At the present time a number of buildings are present at SLAAP and one building that was present at the beginning of this investigation (Building 3) has been removed. The fate of the remaining buildings is currently unknown. To address the uncertainty of which buildings may or may not remain the risk assessment evaluated the footprints under each building, railroad roadway and the Northeast parking area as separate exposure areas. In the event that any existing Site features were demolished this provides the information necessary to address the risks associated with newly exposed soils. This approach also addresses the fact that different industrial activities occurred in different buildings, former buildings or other Site areas and that different chemicals and chemical concentrations are found in each of these. In addition to calculating risks for the individual exposure areas the risk assessment also calculated risks as follows:

- Site wide data Risk calculations were performed for all soils treating them as a single exposure unit. This provides risk information in the event that all current structures (i.e. buildings, parking lots, roadways, railroads, etc.) are removed.
- Hotspot data A number of potential hotspots were evaluated as part of the SSEBS (URS 2003). Potential hotspots are relatively small areas where known or suspected releases may have occurred. Examples include stained soils under machinery locations where the Comprehensive EBS (TTEMI 2000) found chemicals present above screening levels or areas where chemicals were known to have been handled but where no data existed. These hotspot areas typically cover a small fraction of the area covered by the building with which they are associated. For purposes of the risk assessment all soil data collected from the 0-10 foot bgs interval during the SSEBS including those designated as risk assessment samples in the SAP (URS 2002) were included in the hotspot evaluation. Hotspots were defined as discrete areas of contamination where one or more chemicals were present above screening levels (e.g. exceedances). A hotspot could consist of one or more samples. In the event that adjacent samples showed exceedances they were pooled as a single hotspot.

- Samples with no exceedances were used to identify the boundaries of the hotspots and were not included in the hotspot dataset when calculating risks
- Although groundwater in the vicinity of the Site is not used as a drinking water source exposure is possible if shallow groundwater is contacted by excavation workers or if VOCs are released from groundwater into overlying buildings Potential exposure to groundwater at the Site is evaluated in this HHRA on a Site wide basis

A summary of the individual exposure areas and hotspots evaluated in the HHRA is presented in **Table 3 1** and shown on **Figures 3 2 and 3 3**

3 4 EVALUATION OF EXPOSURE ASSUMPTIONS

In order to calculate the chronic daily intake of Site contaminants and to estimate the associated potential health risks a number of exposure parameters must first be defined and quantified The exposure parameter values used in this risk assessment have been selected from the Exposure Factors Handbook (USEPA 1997a 1989b) Office of Solid Waste and Emergency Response (OSWER) Directive 9285 6 03 (Standard Default Exposure Factors USEPA 1991b) RAGS (USEPA 1989a) Peer Review Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (USEPA 2001a) and through the use of professional judgement

Exposure was evaluated for both RME and CTE exposure The RME is an estimate of the maximum exposure that can reasonably be expected to occur The CTE represents a more typical exposure for the average individual As stipulated in **Section 4** of the approved SAP (URS 2002) the exposure parameters used in the risk calculations are listed in **Table 3 2** and described in the following paragraphs

3 4 1 Averaging Time

The assumed lifespan used as the averaging time for evaluating carcinogens as given in the OSWER Directive 9285 6 03 (USEPA 1991b) is 70 years (25 550 days) for all receptors

The averaging time used for evaluating non carcinogens is based on the duration and frequency of exposure For exposure pathways with exposure durations of more than one year the averaging time for non carcinogens is calculated by multiplying the exposure duration times 365 days/year For the Future Excavation/Construction Worker pathway which has an exposure duration of less than one year the averaging time for non carcinogens is an estimate of the total number of days that the construction activity would take to complete (including weekends and holidays) An estimate of 42 days was used for CTE and 84 days for RME

3 4 2 Exposure Duration

Exposure duration refers to the number of years in which exposure occurs On site workers were assumed to have an RME duration of 25 years as given in OSWER Directive 9285 6 03 (USEPA 1991b) A CTE exposure duration of 5 years was assumed based on information supplied by the Bureau of Labor Statistics (U S Department of Labor 1992) showing 5 years to be the average time an individual spends at one job

For the Hypothetical Future Resident the RME exposure duration was assumed to be 30 years (24 years as an adult and 6 years as a small child) which is the 90th percentile for an individual

living in a single residence (USEPA 1989b) Nine years (3 years as an adult 6 years as a small child) which is the 50th percentile for an individual living at a single residence was used to evaluate the CTE scenario These same exposure durations were used to evaluate the trespasser scenario based on the assumption that a trespasser could be a local resident however it was assumed that trespassers were either older children (greater than 6 years old) or adults

Utility installation or building construction is considered the most likely future Site-specific excavation activity This type of activity generally occurs over a relatively short duration Based on professional judgment this activity was estimated to be completed within one year for both the RME and the CTE scenarios

3.4.3 Exposure Frequency

Exposure frequency refers to the total number of days per year spent at the Site

On site workers were assumed to spend 250 days per year on site for both RME and CTE exposure based on a 5 day working week for 50 weeks per year (OSWER Directive 9285 6 03 USEPA 1991b)

Excavation/construction workers were assumed to have an exposure frequency of 60 days (12 workweeks) and 30 days (6 workweeks) for RME and CTE exposure respectively This was based on professional judgement regarding the number of workdays subsurface construction would take to complete as discussed in the SAP (URS 2002)

Because of the location of the Site and the limited size of the evaluated exposure areas trespassers were assumed to visit the Site on an infrequent basis It was assumed that the trespasser will visit the area 12 days per year for RME and 6 days per year for CTE exposure as discussed in the SAP (URS 2002)

Residents were evaluated using the standard default assumption of 350 days per year for both the CTE and RME scenario (USEPA 1991b)

3.4.4 Incidental Soil Ingestion Rate

The incidental soil ingestion rate refers to the amount of soil that is ingested daily via incidental contact (e.g. hand to mouth contact) Missouri Industrial CALM values assume a soil ingestion rate of 100 mg/day This value was applied to the assessment of an on site worker for the RME exposure scenario For calculations of CTE exposure a value of 50 mg/day was used based on recommendations by USEPA (1997a) for worker populations and the Standard Default Exposure Factors (USEPA 1991b) These exposure estimations were also applied to the Site trespasser scenario

Soil excavation activity may involve increased exposure to soil A soil ingestion rate of 330 mg/day as recommended by USEPA (USEPA 2001a) was used to evaluate the RME exposure scenario for the construction worker For calculations of construction worker central tendency exposure a value of 100 mg/day was used This is the CTE ingestion rate for construction work recommended by USEPA's Technical Review Workgroup for lead

For RME residential exposure scenarios USEPA recommends the use of soil ingestion rates of 100 mg/day for individuals over the age of 6 years and 200 mg/day for 0 to 6 year old children (USEPA 1991b) CTE soil ingestion rates were assumed to be one-half the RME rate

(i.e. 50 mg/day for individuals over the age of 6 years and 100 mg/day for 0 to 6 year old children)

3.4.5 Incidental Groundwater Ingestion Rate

The incidental groundwater ingestion rate refers to the amount of groundwater that is ingested daily via incidental contact (e.g. hand to mouth contact). Based on professional judgement a RME value of 2 ml/day was used as the incidental groundwater ingestion rate for excavation activity. A value of one half of the RME rate 1 ml/day was used for CTE exposure.

3.4.6 Body Weight

The body weight for adults and children were obtained from OSWER Directive 9285.6.03 (USEPA 1991b). The assumed body weight for adults is 70 kg. This value was used for on site workers, excavation/construction workers, adult residents and trespassers. For 0-6 year old child residents a time weighted average body weight of 15 kg was used.

3.4.7 Surface Area of Exposed Skin

Exposed skin surface area is important when evaluating uptake of chemicals that are absorbed dermally. For dermal exposure to soil an RME surface area of 3 300 cm² was used to evaluate potential adult receptor scenarios (hypothetical on site workers, excavation/construction workers, trespassers and adult residents) and 1913 cm² for the child resident based on the surface areas of face, forearms and hands (USEPA 1997a). For central tendency exposure the total exposed surface area assumed to be limited to the head and hands is 2 000 cm² for adults and 1440 cm² for children (USEPA 1997a). The same adult skin surface areas were used for evaluating potential exposure of excavation/construction workers to shallow groundwater.

3.4.8 Dermal Soil Adherence Factor

Dermal soil adherence is used in conjunction with exposed skin surface area to define the total amount of soil adhering to exposed skin surfaces. An RME soil adherence rate of 0.9 mg/cm² based on the 95th percentile reported in RAGS Part E (USEPA 2001b) was used to evaluate the RME scenario for the excavation/construction worker scenario. For the excavation/construction worker scenario an adherence rate of 0.2 mg/cm² was used to evaluate CTE exposure.

For Site workers an RME adherence rate of 0.2 mg/cm² was based on the value recommended for commercial/industrial workers in the USEPA soil screening guidance (USEPA 2001a). The CTE adherence rate of 0.03 mg/cm² was based on the reported mean soil adherence of soil to hands, head and arms for groundskeepers (USEPA 1997a).

For trespassers and residents RME and CTE adherence rates were taken from RAGS Part E (USEPA 2001b). An adherence rate of 0.3 mg/cm² was used for RME and 0.04 mg/cm² was used for CTE based on the reported 95th percentile and mean soil adherence of soil to hands, head and arms for a soccer players (USEPA 1997a). (Note: Soil adherence rates for residents/trespassers per se are not presented in RAGS. Soccer players were chosen as a surrogate for trespassers and residents because they represent an outdoor activity with relatively high soil contact by youths.)

3 4 9 Dermal Soil Absorption Factor

Dermal soil absorption factors used to estimate chemical absorption through the skin are chemical class specific values. Dermal soil absorption values identified in RAGS Part E (USEPA 2001b) were used in the risk assessment. This guidance indicates a dermal soil absorption fraction of 10% for most semi-volatile compounds and chemical specific values for several others (including most of the SVOCs found at SLAAP). Unless otherwise specified metals and volatile compounds were not evaluated for dermal exposure as indicated in the guidance (USEPA 2001b).

3 4 10 Permeability Constant

The permeability constant is used when evaluating uptake of chemicals that are absorbed dermally from aqueous media. Chemical specific permeability constants as reported in RAGS Part E (USEPA 2001b) were used to estimate dermal absorption of chemicals from water. For inorganic chemicals without chemical specific values the generic permeability constant for water (0.001 cm/hour) was used.

3 4 11 Exposure Time

Exposure time used to evaluate inhalation by an excavation/construction worker refers to the number of hours per day in which the exposure occurs. A standard workday is eight hours long. The RME exposure time for the future excavation/construction worker of 4 hours per day assumes that half of that time is spent actually working in the trench. A CTE exposure duration of 2 hours per day was assumed based on professional judgement.

3 4 12 Inhalation Rate

The inhalation rate is used to estimate the volume of trench air that an excavation/construction worker might breath while working in a trench. Inhalation rates were taken from the Exposure Factors Handbook (USEPA 1997a). An inhalation rate of 2.05 m³/hour based on the assumption that half of the time spent working in a trench would involve moderate activity levels and half heavy activity levels was used to evaluate the RME scenario. For the CTE scenario a rate of 1.3 m³/hour was used based on the assumption that half of the time spent working in a trench would involve light activity levels and half would involve moderate activity levels.

3 5 EXPOSURE POINT CONCENTRATIONS

Exposure Point Concentrations are the chemical concentrations to which a receptor is exposed when contact is made with a specific environmental medium. Site data for each exposure area were collected using two different approaches. For evaluating representative risks for each exposure area risks were calculated using sample data collected using a systematic sampling grid. In addition separate hotspot risk evaluations were performed for any hotspots identified in each exposure area as described in Section 3 3. The purpose of this two tiered evaluation was to provide Site risk managers with sufficient risk information to support hotspot removal if warranted without providing a biased overview of overall risks for each exposure area.

In general the 95% upper confidence limit of the mean (95% UCL) was used to estimate the RME and the average concentration was used to estimate the CTE exposure point concentration for chemicals. The 95% UCL was calculated by various methods based on guidance from USEPA as described in later sections.

If a sample was non detect a surrogate concentration of ½ of the detection limit was used for calculation of the exposure point concentration.

The 95% UCL was not calculated for data sets with only one detected concentration. For these chemicals the maximum detected concentration was used as the RME exposure point concentration. In addition the maximum detected concentration was used as the RME exposure point concentration in cases where the 95% UCL exceeded the maximum detected concentration. **Figure 3-4** presents a flow diagram outlining the rationale used in the calculation of the 95% UCL. The following sections briefly describe the various statistical methods used to calculate the 95% UCL.

3.5.1 Calculation of the 95% UCL for lognormally distributed datasets

For chemicals displaying a lognormal distribution pattern the 95% UCL was calculated using the equation shown below:

$$UCL = e^{(x + 0.5s^2 + sH/\sqrt{n-1})}$$

Where

UCL = upper confidence limit

e = base of the natural log (2.718)

x = mean of the log transformed data

s = standard deviation of the log transformed data

H = H statistic

n = number of samples

3.5.2 Calculation of the 95% UCL for normally distributed datasets

For chemicals displaying a normal distribution pattern based on USEPA guidance (USEPA 1992) the 95% UCL was calculated using the equation shown below:

$$UCL = x + t(s/\sqrt{n})$$

Where

UCL = upper confidence limit

x = mean of the untransformed data

s = standard deviation of the untransformed data

t = Student t statistic

n = number of samples

3.5.3 Calculation of the 95% UCL based on Non parametric Methods

The accuracy of the above statistical methods relies on the assumption that the data set being analyzed is distributed normally or lognormally. For sample data with other distributions the use of the H or t statistic to estimate the 95% UCL can result in a 95% UCL value that is unrealistically large. Based on USEPA guidance a non parametric statistical method for calculating the 95% UCL may be more appropriate for chemicals displaying a non lognormal distribution (USEPA 1997b 2002c). Although a technical discussion of the available non parametric methods is beyond the scope of this document these include several bootstrap and jackknife methods. Depending on the nature/statistical distribution of the data collected at the Site if the H or t statistic approaches were deemed to be inappropriate a non parametric method was used to calculate exposure point concentrations.

The toxicity assessment provides a summary of the toxicity values that are used to evaluate potential adverse health effects associated with chemical exposure. The following sections provide an overview of the development and use of these toxicity values in this risk assessment.

4.1 TOXICITY ASSESSMENT OF NON CARCINOGENIC EFFECTS

To estimate the potential non carcinogenic hazards posed by the COPCs at the Site a hazard index (HI) approach was used. The concept of the hazard index is based on the assumption that non carcinogenic toxicological effects of chemicals occur only after a threshold dose is achieved. The reference dose (RfD) for a compound is an estimate of the threshold dose at which the most sensitive human population will experience an observed adverse effect for that compound. The hazard index is the ratio of the chronic daily intake of a chemical to its specific reference dose. As long as the chronic daily intake of a chemical is less than the reference dose the exposure is unlikely to result in any adverse non carcinogenic health effect. A hazard index in excess of one indicates that the chronic daily intake has exceeded the reference dose and a potential health hazard may exist. A hazard index of less than one indicates that adverse health effects are unlikely to occur.

The first step in developing an RfD is to identify a threshold dose or no observed-adverse-effect level (NOAEL). A NOAEL is the highest level of a chemical (determined in epidemiological studies or animal studies) at which there is no statistically or biologically significant effect of concern often called the critical toxic effect. For certain substances only a LOAEL or lowest observed adverse-effect level has been determined. This is the lowest dose of a substance that produces either a statistically or biologically significant indication of an adverse toxic effect. The NOAEL or the LOAEL may be used to calculate the RfD of a particular chemical.

RfDs are calculated by dividing the NOAEL (or LOAEL) by a combined uncertainty factor which generally ranges from 10 to 10 000. Individual uncertainties include variations in the sensitivity of individuals within a population the extrapolation of data from experimental animals to humans an incomplete database less than lifetime to lifetime extrapolation and LOAEL to NOAEL extrapolation. The RfD is expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg/day).

The USEPA defines a chronic RfD as an estimate of a daily exposure level for the human population that is unlikely to result in deleterious effects during a lifetime (i.e. 70 years). A chronic RfD is used to evaluate the potential non carcinogenic hazards associated with long term chemical exposures.

Subchronic RfDs have been developed for a few chemicals to characterize potential non carcinogenic hazards associated with short term chemical exposures. The USEPA defines subchronic exposure as periods ranging from 2 weeks to 7 years (USEPA 1989a). In this risk assessment subchronic RfDs were used to evaluate the future construction/utility worker scenarios when available. Chronic RfDs were used for this scenario if there were no subchronic values.

4 2 TOXICITY ASSESSMENT OF CARCINOGENIC EFFECTS

To estimate the potential risk from exposure to carcinogenic chemicals of potential concern at the Site incremental carcinogenic risks (i.e. cancer risks attributable to site contaminants) were calculated. The incremental cancer risk for a chemical is the product of the chronic daily intake of the chemical multiplied by a cancer slope factor (SF) for that chemical. The incremental carcinogenic risk provides an estimate of the potential increase in cancer incidence for a receptor population. An incremental cancer risk of 1×10^{-6} corresponds to 1 chance in one million that an individual will acquire cancer due to exposure to Site chemical. A risk range of 10^{-4} to 10^{-6} represents USEPA's opinion on what are generally acceptable levels for a site (National Oil and Hazardous Substances Pollution Contingency Plan March 1990 40 CFR 300).

Slope factors are used to evaluate potential carcinogenic effects and are developed based on a dose-response curve for carcinogenicity of the specific chemical. Given the large degree of uncertainty that exists in predicting actual cancer risks, the USEPA takes a precautionary conservative approach when developing SFs to insure that risks from carcinogenic chemicals are not underestimated. The SF is used to estimate an upper bound probability of an individual developing cancer as a result of exposure to a potential carcinogen.

In estimating risks posed by potential carcinogens, USEPA generally assumes that any exposure level is associated with a finite probability however minute of producing a carcinogenic response. USEPA assumes that a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation. This mechanism for carcinogenicity is referred to as non threshold since there is theoretically no level of exposure for such a substance that does not pose a small though finite probability of producing a carcinogenic response.

It is generally assumed by USEPA in developing SFs that the risk of cancer is linearly related to dose. A linearized multistage model is one of the most commonly used models by USEPA for low dose extrapolation of experimentally derived data to the low dose range. This mathematical model is based on the multi-stage theory of carcinogenesis wherein the response is assumed to be linear at low doses. From the slope of the extrapolation curve estimated by the model, USEPA calculates the upper 95th percent confidence limit of the slope. The SF expressed in units of (mg/kg/day)⁻¹ is used to convert the chronic daily intake of a chemical normalized over a lifetime directly to a cancer risk. This represents an estimation of an upper bound incremental lifetime probability that an individual will develop cancer as a result of exposure to a potential carcinogen. This model provides an estimate of cancer risk at low doses and is likely to overestimate the actual cancer risk which may be as low as zero.

4 3 SOURCES OF THE TOXICITY VALUES

The hierarchy of sources of toxicity values used in this risk assessment are listed below:

- USEPA Integrated Risk Information System Database (IRIS) (USEPA 2003a)
- Health Effects Assessment Summary Table (HEAST) (USEPA 1997c)
- USEPA's National Center for Environmental Assessment (NCEA) Provisional Values (as presented in USEPA 2002a)

Summaries of the Toxicity Values used in this Risk Assessment are presented in Table 4 1. The carcinogenic slope factors used for polychlorinated biphenyls in the calculations vary by exposure pathway and scenario as specified in the IRIS database (USEPA 2003a). For dermal contact with and incidental ingestion of soil scenarios slope factors of 1.0 (mg/kg day)⁻¹ (CTE) and 2.0 (mg/kg day)⁻¹ (RME) were used respectively. For scenarios involving incidental ingestion of groundwater slope factors of 0.3 (mg/kg day)⁻¹ (CTE) and 0.4 (mg/kg day)⁻¹ (RME) were used.

4.4 TOXICITY ASSESSMENT OF LEAD

Lead is not evaluated in a risk evaluation using the same methods applied to other chemicals. While it has both carcinogenic and non carcinogenic properties USEPA does not furnish either slope factors (SFs) or reference doses (RfDs) for lead. Lead is a neurodevelopmental toxicant and its toxic properties are related to an individual's age. Young children are especially sensitive to lead. Relatively low levels of lead exposure can cause adverse effects in children. This is because 1) Children have a higher rate of lead absorption through the gastrointestinal tract than adults and 2) because young children's nervous systems are still developing. Adult nervous systems being relatively static organs with little potential for growth or regeneration are relatively resistant to lead toxicity.

The USEPA has developed two computer models to estimate lead uptake from various environmental media. Since children have been identified as the most sensitive population to toxic effects of lead both models address childhood exposure either directly or indirectly (e.g. fetal exposure). One model termed the Integrated Exposure Uptake Biokinetic (IEUBK) Model predicts the amount of lead that will be found in the bloodstream of a directly exposed child (USEPA 1994). The other model referred to as the Adult Lead Model (USEPA 1996) is designed to address adult exposure in an industrial setting. The receptor of concern in the adult lead model is an unborn fetus in a pregnant worker. The IEUBK model is considered applicable for hypothetical future residents and the adult lead model for the other scenarios evaluated at SLAAP.

The IEUBK model as applied by MDNR identifies an allowable surface soil lead level of 260 mg/kg for residential soils a level thought to be protective of children. The Adult Lead Model results in an allowable surface soil lead concentration for uncontrolled exposures in the range of 750 - 1,750 mg/kg depending on the demographic makeup of the workforce. This range is designed to be protective of a developing fetus in a pregnant Site worker. For this risk evaluation lead soil concentrations were compared to both 260 mg/kg and the 750 - 1,750 mg/kg range.

The purpose of risk characterization is to quantify and describe the potential health risks associated with Site specific impacts

In this portion of the Risk Assessment potential health risks are estimated for each COPC and exposure pathway. These risk estimates are calculated using the exposure parameters developed in Section 3 and the toxicity values reported in Section 4.

5.1 EQUATIONS AND MODELS USED TO CALCULATE RISKS AND HAZARDS

5.1.1 General Risk Equations

Potential cancer risks and non cancer hazard quotients have been calculated using the general equations that follow. Because residences often include children exposure terms for children are included in the applicable cancer equations for the Hypothetical Future Resident scenario (i.e. dermal contact and incidental ingestion of soil). For adult only scenarios (industrial/commercial worker excavation/construction worker trespasser/site visitor) the child exposure terms are eliminated from the equations.

Equation 1 (soil ingestion – cancer)

Resident Child and adult combined

$$CR = (CS * CF_1 * EF * SF_{oral} * ((IR_{child} * ED_{child} / BW_{child}) + (IR_{adult} * ED_{adult} / BW_{adult}))) / (AT_c)$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$CR = (CS * CF_1 * IR_{adult} * EF * ED_{adult} * SF_{oral}) / (BW_{adult} * AT_c)$$

Equation 2 (soil ingestion – non cancer)

Resident Child only

$$HI = (CS * CF_1 * IR_{child} * EF * ED_{child}) / (BW_{child} * AT_{nc} * RfD_{oral})$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$HI = (CS * CF_1 * IR_{adult} * EF * ED_{adult}) / (BW_{adult} * AT_{nc} * RfD_{oral})$$

Equation 3 (dermal contact with soil cancer)

Resident - Child and adult combined

$$CR = (CS * CF_1 * AD * AB * EF * SF_{oral} * ((SA_{child} * ED_{child} / BW_{child}) + (SA_{adult} * ED_{adult} / BW_{adult}))) / (AT_c)$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$CR = (CS * CF_1 * AD * AB * SA_{adult} * EF * ED_{adult} * SF_{oral}) / (BW_{adult} * AT_c)$$

Equation 4 (dermal contact with soil non cancer)

Resident Child only

$$HI = (CS * CF_1 * AD * AB * SA_{child} * EF * ED_{child}) / (BW_{child} * AT_{nc} * RfD_{oral})$$

Industrial/Commercial Excavation/Construction Trespasser/Site visitor

$$HI = (CS * CF_1 * AD * AB * SA_{adult} * EF * ED_{adult}) / (BW_{adult} * AT_{nc} * RfD_{oral})$$

Equation 5 (inhalation of volatilized soil contaminants – cancer)

Excavation/Construction

$$CR = (C_{air} * IH_{adult} * ET * EF * ED_{adult} * SF_{inhale}) / (AT_c * BW_{adult})$$

Equation 6 (inhalation of volatilized soil contaminants – non-cancer)

Excavation/Construction

$$HI = (C_{air} * IH_{adult} * ET * EF * ED_{adult}) / (AT_{nc} * BW_{adult} * RfD_{inhale})$$

Equation 7 (groundwater ingestion cancer)

Excavation/Construction

$$CR = (CW * IR_{adult} * EF * ED_{adult} * SF_{oral}) / (BW_{adult} * AT_c)$$

Equation 8 (groundwater ingestion – non cancer)

Excavation/Construction

$$HI = (CW * IR_{adult} * EF * ED_{adult}) / (BW_{adult} * AT_{nc} * RfD_{oral})$$

Equation 9 (direct dermal contact with groundwater cancer)

Excavation/Construction

$$CR = (CW * CF_2 * SA_{adult} * PC * ET * EF * ED_{adult} * SF_{oral}) / (BW_{adult} * AT_c)$$

Equation 10 (direct dermal contact with groundwater non cancer)

Excavation/Construction

$$HI = (CW * CF_2 * SA_{adult} * PC * ET * EF * ED_{adult}) / (BW_{adult} * AT_{nc} * RfD_{oral})$$

Where

CR = Cancer risk (unitless)

CS = Contaminant concentration in soil (mg/kg)

CW = Contaminant concentration in water (mg/L)

C_{air} = Contaminant concentration in air (mg/m³)

IR_{adult} = Adult ingestion rate (soil mg/day groundwater L/day)

IH_{adult} = Adult inhalation rate (m³/hr)

IR_{child} = Child ingestion rate (soil mg/day)

EF = Exposure frequency (days/year)

ED_{child} = Child exposure duration (years)

ED_{adult} = Adult exposure duration (years)

BW_{child} = Child body weight (kg)

BW_{adult} = Adult body weight (kg)

CF₁ = Conversion factor (kg/mg)

CF₂ = Conversion factor (L/cm³)

AT_c = Averaging time for carcinogenic effects (days)

AT_{nc} = Averaging time for non carcinogenic effects (days)

SA_{child} = Child exposed dermal surface area (cm²/day)

SA_{adult} = Adult exposed dermal surface area (cm²/day)

AB = Absorbed fraction (unitless)

AD = Adherence factor for soil (mg/cm²)

PC = Permeability constant (cm/hr)

ET = Exposure Time (hours/day)

SF_{oral} = Oral cancer slope factor (mg/kg day)¹

RfD_{oral} = Oral reference dose (mg/kg day)

SF_{inhale} = Inhalation cancer slope factor (mg/kg day)¹

RfD_{inhale} = Inhalation reference dose (mg/kg-day)

5 1 2 Contaminant Volatilization into a Building

The hazard/risks associated with volatilization into a building were estimated using the Johnson and Ettinger (J&E) model for chemical volatilization into a building (USEPA 2003). This is a spreadsheet application obtained from the USEPA that is used to evaluate potential emissions of VOCs from subsurface soil and groundwater into an overlying building. Given that no VOCs were found above screening levels in soil only groundwater was evaluated using this model. Calculations were performed only for volatile COPCs. Per USEPA guidance (USEPA 1991a) volatile chemicals are defined as chemicals with a molecular weight of less than 200 and a Henry's Law constant of 1×10^5 atm m³/mole or greater.

Default exposure parameters were used in all J&E calculations (i.e. the standard J&E screening defaults). These default parameters are designed to be protective of residential properties (homes) and are considered protective for other building uses such as commercial/industrial buildings. Exposure point concentrations were based on the maximum detected VOC concentrations in groundwater.

5 1 3 Groundwater Chemical Volatilization into a Trench

The hazard/risks associated with inhalation of groundwater chemicals volatilized into a trench were estimated on a Site wide basis using a model outlined in a USEPA memo Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Groundwater off gassing Volatile Organic Chemicals (USEPA 1999). Exposure point concentrations were based on the maximum detected chemical concentrations in groundwater. The model estimates the concentration of a groundwater chemical in the trench air based on the multiplication of the chemical concentration in the groundwater by a volatilization factor for the chemical. The volatilization factor is based on the rate of mass transfer of the chemical from the groundwater to the air and the rate of air exchange between the trench and surrounding air. Standard risk equations are then applied to calculate the risk/hazard associated with inhalation of the estimated trench air concentrations.

Conservative default values (USEPA 1999) for the mass transfer of volatile organic compounds were used. The model was based on a trench 30 meters long and 3 meters high. The trench width is not used in this model. An air exchange rate of 0.15 exchanges per second (based on a 10 mile per hour wind speed) was used to account for air replenishment in the trench. A mixing factor of 0.5 was incorporated to account for incomplete mixing of air in the trench.

5 1 4 Exposure to Lead in Soils

For adult worker scenarios lead concentrations were compared with the allowable lead concentrations in exposed soil as estimated by the USEPA Adult Lead Model (USEPA 1996). For adult worker scenarios soil concentrations of less than 750 1 750 mg/kg are considered protective to a developing fetus in a pregnant Site worker (the most sensitive endpoint of concern). For resident and trespasser scenarios lead levels were compared to the MDNR CALM value of 260 mg/kg which in turn is based on the IEUBK lead model for children (USEPA 1994).

5.2 RESULTS

Non carcinogenic hazard indices and carcinogenic risks for Site soils for each receptor population are presented on an area by area basis as summarized in the sections below. Tables 5.1 through 5.4 summarize the risks and hazards associated with Site soils. Risks associated with groundwater are evaluated on a Site wide basis and are summarized in Tables 5.5 and 5.6. Supporting risk calculations/spreadsheets are presented in Attachment A.

5.2.1 Building 1

COPCs were identified in both surface soil and subsurface soil at Building 1.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 2×10^{-7} (trespassers/site visitors) to 1×10^{-5} (hypothetical future residents) and RME hazard indices ranged from 0.0009 (trespassers/site visitors) to 0.2 (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3×10^{-6} and the RME hazard index was 0.02.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0.10 feet bgs) was estimated at 5×10^{-8} and the RME hazard index was 0.01.

5.2.2 Building 2

COPCs were identified in both surface soil and subsurface soil at Building 2.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 6×10^{-7} (trespassers/site visitors) to 4×10^{-5} (hypothetical future residents) and RME hazard indices ranged from 0.02 (trespassers/site visitors) to 3 (hypothetical future residents). Aroclor 1248 was the primary contributor to the elevated hazard index for the hypothetical future resident scenario. The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 9×10^{-6} and the RME hazard index was 0.3.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0.10 feet bgs) was estimated at 2×10^{-7} and the RME hazard index was 0.2.

Lead was also identified as a COPC for Building 2 at a maximum detected concentration of 721 mg/kg (surface soil). The RME exposure point concentration for surface soil was 180 mg/kg which is below the level of concern of 260 mg/kg for child populations. The RME exposure point concentration for combined subsurface and surface soil was 68 mg/kg which is below the target range of 750-1,750 mg/kg for adult populations.

5.2.3 Building 4

COPCs were identified in both surface soil and subsurface soil at Building 4.

None of the surface soil COPCs are potential carcinogens. RME hazard indices ranged from 0.0004 (trespassers/site visitors) to 0.1 (hypothetical future residents). The RME hazard index for industrial/commercial workers which is considered the most likely future use of the Site was 0.009.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 3×10^{-8} and the RME hazard index was 0.005

5.2.4 Building 5

COPCs were identified in both surface soil and subsurface soil at Building 5

RME cancer risks associated with surface soil (0-0.5 feet bgs) ranged from 4×10^{-6} (trespassers/site visitors) to 2×10^{-4} (hypothetical future residents) and RME hazard indices ranged from 0.03 (trespassers/site visitors) to 6 (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 5×10^{-5} and the RME hazard index was 0.5. DDT was the primary contributor to the elevated hazard index. DDT and benzo(a)pyrene were the primary contributors to the elevated cancer risks.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 1×10^{-6} and the RME hazard index was 0.9

Lead was also identified as a COPC for Building 5 at a maximum detected concentration of 1790 mg/kg (surface soil). The RME exposure point concentration for surface soil was 333 mg/kg which exceeds the level of concern of 260 mg/kg for child populations but not the target range of 750-1750 mg/kg for adult populations. The RME exposure point concentration for combined subsurface and surface soil was 173 mg/kg which is below the target range for adult populations.

5.2.5 Building 6

COPCs were identified in both surface soil and subsurface soil at Building 6

RME cancer risks associated with surface soil (0-0.5 feet bgs) ranged from 3×10^{-9} (trespassers/site visitors) to 2×10^{-7} (hypothetical future residents) and RME hazard indices ranged from 0.0001 (trespassers/site visitors) to 0.04 (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 5×10^{-8} and the RME hazard index was 0.003.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 1×10^{-8} and the RME hazard index was 0.02

5.2.6 Building 7

COPCs were identified in both surface soil and subsurface soil at Building 7

RME cancer risks associated with surface soil (0-0.5 feet bgs) ranged from 6×10^{-7} (trespassers/site visitors) to 3×10^{-5} (hypothetical future residents) and RME hazard indices ranged from 0.01 (trespassers/site visitors) to 0.2 (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 8×10^{-6} and the RME hazard index was 0.02

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 1×10^{-7} and the RME hazard index was 0.02.

Lead was also identified as a COPC for Building 7 at a maximum detected concentration of 900 mg/kg (surface soil). The RME exposure point concentration for surface soil was 136 mg/kg which is below the level of concern of 260 mg/kg for child populations. The RME exposure point concentration for combined subsurface and surface soil was 80 mg/kg which is below the target range of 750-1,750 mg/kg for adult populations.

5.2.7 Building 8

COPCs were identified in both surface soil and subsurface soil at Building 8.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 3×10^{-8} (trespassers/site visitors) to 1×10^{-6} (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 4×10^{-7} . None of the surface soil COPCs have RfDs so no hazard indices were calculated.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 3×10^{-8} and the RME hazard index was 0.003.

5.2.8 Northeast Parking Area

COPCs were identified in both surface soil and subsurface soil at the Northeast Parking Area.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 2×10^{-7} (trespassers/site visitors) to 1×10^{-5} (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3×10^{-6} . None of the COPCs have RfDs so no hazard indices were calculated.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 7×10^{-8} .

5.2.9 Railroads

COPCs were identified in both surface soil and subsurface soil at the Railroads.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 2×10^{-8} (trespassers/site visitors) to 1×10^{-6} (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 3×10^{-7} . None of the surface soil COPCs have RfDs so no hazard indices were calculated.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0-10 feet bgs) was estimated at 8×10^{-9} and the RME hazard index was 0.005.

5.2.10 Roadways

COPCs were identified in both surface soil and subsurface soil at the Roadways

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 6×10^{-8} (trespassers/site visitors) to 3×10^{-6} (hypothetical future residents) and RME hazard indices ranged from 0.002 (trespassers/site visitors) to 0.5 (hypothetical future residents). The RME cancer risk for industrial/commercial workers which is considered the most likely future use of the Site was estimated at 8×10^{-7} and the RME hazard index was 0.04.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0.10 feet bgs) was estimated at 3×10^{-8} and the RME hazard index was 0.09.

5.2.11 Hotspot Areas

Hotspot areas identified from the sampling results cover relatively small areas of the Site and as such are likely to overestimate risks to individuals who will work in larger areas. The exception is Hotspot 2 which essentially covers the entire footprint of Building 2². Cancer risks and hazard indices for each of the individual Hotspot areas are summarized in Tables 5.1 through 5.4 and are not repeated verbatim here. Hotspots that exceeded either a cancer risk of 1×10^{-4} or a hazard index of 1 are briefly discussed below.

For surface soils Hotspot 5A was the only Hotspot that exceeded a cancer risk of 1×10^{-4} (residents 1×10^{-3} , industrial/commercial workers 3×10^{-4}). DDT and benzo(a)pyrene were the primary contributors to risk at Hotspot 5A. Hotspots 2 (resident HI of 2) and 5A (resident HI of 33 and industrial/commercial worker HI of 3) were the only Hotspots that exceeded a hazard index of 1. For Hotspot 2 Aroclor 1248 was the primary contributor to the elevated hazard index for Hotspot 5A. DDT was the primary contributor.

For combined subsurface and surface soils no Hotspots exceeded a cancer risk of 1×10^{-4} . Hotspot 5A was the only Hotspot that exceeded a hazard index of 1 (excavation/construction worker HI of 8). DDT was the primary contributor to the elevated hazard index.

5.2.12 Site Wide Soils

Site wide risks were estimated by combining soil samples from across the entire Site. Just as the use of Hotspot data can potentially overestimate risk, the combining of data from across the entire Site can potentially underestimate risks to individuals who may only be exposed to only a portion of the Site.

For the Site wide evaluation COPCs were identified in both surface soil and subsurface soil.

² Hotspot 2 is considered somewhat of an anomaly relative to the other hotspots. Because this hotspot covers such a large area it contains a large number (19) of samples including most of the systematic (gridded) samples collected for the risk assessment as well as characterization samples collected throughout the building for the SSEBS. As a result the calculated hotspot RME exposure point concentration for PCB of 2.4 mg/kg is slightly less than that calculated for the Building 2 risk samples (3.3 mg/kg) and the resultant hazard index calculations are also slightly lower for the hotspot.

RME cancer risks associated with surface soil (0.05 feet bgs) ranged from 2×10^{-6} (trespassers/site visitors) to 1×10^{-4} (hypothetical future residents) and RME hazard indices ranged from 0.03 (trespassers/site visitors) to 6 (hypothetical future residents). The primary contributors to the elevated hazard index were Aroclor 1248, Aroclor 1254, and DDT. The RME cancer risk for industrial/commercial workers, which is considered the most likely future use of the Site, was estimated at 3×10^{-5} and the RME hazard index was 0.6.

The RME cancer risk associated with construction/excavation worker exposure to combined surface and subsurface soil (0.10 feet bgs) was estimated at 5×10^{-7} and the RME hazard index was 0.7.

Lead was also identified as a COPC on a Site wide basis with a maximum detected concentration of 1790 mg/kg (surface soil). The RME exposure point concentration for surface soil was 68 mg/kg, which is below the level of concern of 260 mg/kg for child populations. The RME exposure point concentration for combined subsurface and surface soil was 32 mg/kg, which is below the target range of 750-1750 mg/kg for adult populations.

5.2.13 Site-Wide Groundwater

Groundwater was evaluated on a Site-wide basis for potential vapor intrusion into buildings and construction trenches and for direct contact (dermal and incidental ingestion) pathways in a trench.

As seen in **Table 5.5**, risks and hazards associated with vapor intrusion into a building are low. The total cancer risk is 1.4×10^{-6} and the hazard index is 0.011. It is important to note that the maximum detected concentrations of all volatile COPCs were found in the same well (02MW 01). Although groundwater was evaluated on a Site wide basis, the results from the J&E modeling are most representative for the area immediately adjacent to well 02MW 01; risks for other areas of the Site are likely to be lower.

Similar to vapor intrusion into a building, risks associated with direct exposure to groundwater in a trench and inhalation of VOCs released from groundwater into the trench are also low (**Table 5.6**). The RME hazard index is estimated to be 0.025 and the RME cancer risk is 6.6×10^{-7} .

5.2.14 Building Related Materials

As discussed in **Section 3.2**, buildings on site may contain contaminants such as lead, PCBs or asbestos. Risks associated with such materials cannot be readily quantified using standard risk assessment protocols; however, as discussed below, they have been evaluated to some extent as part of the SSEBS.

PCBs, asbestos and lead based paint are all believed to be present at concentrations exceeding regulatory action levels on multiple building surfaces across the Site. PCBs have been detected in excess of action levels in wipe samples from buildings 1, 4 and 5 and above the CALM (MDNR, 2001) in concrete samples from Building 2. Asbestos has been found in buildings throughout the Site in materials such as thermal systems insulation, transite siding, wall coverings and floor tiles. No comprehensive lead based paint survey of the facility has been conducted, but lead based paint was found in the former Building 3 and is assumed to be present in all buildings at the Site.

The exceedance of regulatory standards indicates the potential for unacceptable exposure to workers in one or more buildings as they currently exist. Any building on Site that is to be occupied should be thoroughly surveyed to identify materials containing contamination that could affect the proposed use of that building.

The USEPA guidance for risk assessments provides a systematic means for organizing analyzing and presenting information on the nature and magnitude of potential risks to human health posed by exposure to chemicals based on current and hypothetical future exposure pathways. Despite the advanced state of the current methodology uncertainties and limitations are inherent in the risk assessment process. The uncertainty can lead to an over or under estimation of potential risks. Available data quality incomplete information about existing conditions and future circumstances as well as other factors discussed below contribute to these uncertainties and limitations.

This section identifies some of the uncertainties associated with this risk assessment in order to help site decision makers (USEPA MDNR USACE Department of the Army [BRAC] etc.) make informed decisions about future site use. Uncertainties are discussed as they relate to each of the following portions of the risk assessment:

- Data collection
- Data evaluation
- Exposure point concentrations
- Exposure assessment
- Toxicity assessment
- Risk characterization

6.1 DATA COLLECTION

There are several sources of uncertainty associated with data collection. These may include both sampling and analysis.

6.1.1 Sampling Uncertainties

In the risk assessment it was assumed that samples collected were representative of the area to which various populations may be exposed. However the collected samples may not be completely representative due to random variability of samples. Chemicals in Site soils may not be homogeneously distributed in the environment. Variability in the selection of sampling locations may result in either an over or under estimation of actual chemical concentrations and thus an over or under-estimation of Site risks.

Another sampling uncertainty involves the suite of analytes that were analyzed. In particular dioxin analysis was not conducted over most of the Site. In the area where dioxin analysis was conducted (Building 2) the dioxins contributed 2×10^{-5} risk to the residential scenario. Samples collected around the outside of Building 2 contained lower dioxin levels. Given the incineration activities that occurred at Building 2 in conjunction with the presence of PCBs it is not surprising that dioxins were present. While it is likely that dioxin levels are lower on other portions of the Site and that some dioxins are likely to be present as anthropogenic background the lack of dioxin data may result in an underestimation of risk for the remainder of the Site.

6 1 2 Sampling Analysis

Samples were analyzed using USEPA approved procedures and were subject to data validation procedures to assure that data were suitable for use in decision making. However sample analysis is subject to uncertainties with precision and accuracy. Uncertainties associated with precision and accuracy of analytical methods are generally random. While these sources of error are typically of low magnitude compared to other sources of uncertainty they may contribute to an over or under estimation of risks. Given the extensive data validation efforts that were performed on the Site data it is reasonable to conclude that the data used in the HHRA were of acceptable quality.

6 2 DATA EVALUATION

In evaluating data it was assumed that a chemical not detected in a given sample was actually present at one half of its sample quantitation limit. These concentrations are used in the calculation of the arithmetic mean and 95% UCL of a chemical concentration. This is a conservative approach that may lead to an over estimation of risks when sample quantitation limits are high or measured chemical concentrations are very low.

6 3 EXPOSURE POINT CONCENTRATIONS

The 95% UCL of a chemical concentration was used to estimate the RME exposure point concentration for that chemical in some instances. This is a conservative estimation of the chemical concentration and likely results in an over estimation of potential risk. For this reason CTE values were also calculated to characterize the average risks.

In the case of groundwater which was evaluated on a Site-wide basis the highest measured concentrations were used as the exposure point concentrations. This is a worst case scenario that could lead to an over estimation of Site related risks for some portions of the Site.

It was conservatively assumed that chemical concentrations would remain unchanged with time. The potential reduction in concentration by migration degradation and natural attenuation was not considered. In reality these processes will likely reduce the chemical concentrations for future exposure scenarios. The use of existing chemical concentrations for future use scenarios likely results in an over estimation of potential Site related risks.

In some cases models (EMSOFT Johnson and Ettinger etc.) were used to characterize the transport of a chemical from the source media to an exposure point. These models are generalizations of the many interacting transport mechanisms that may be present for a chemical at a Site. The ability of these models to accurately predict chemical transport may vary depending on the environmental conditions present at the Site. The models are generally conservative containing assumptions and estimations of chemical properties that likely over estimate the amount of chemical that is available for exposure. In addition they do not account for all modes of transport and degradation some of which may attenuate the movement of the chemical from the source area to the exposure point. In contrast the use of Site specific assumptions such as mean wind speed could lead to an underestimation of exposure point concentrations during days when there is little wind. Given that the HHRA is intended to evaluate risks and hazards over an extended time (i.e. at least one month) the use of such Site

specific values will probably not result in any underestimation of risks and hazards. Given the other conservative elements inherent in these models the use of such models is likely to result in an overestimation of risks and hazards rather than an underestimation.

Several of the models (EMSOFT groundwater to trench volatilization model etc.) used in the estimation of exposure point concentrations are not sophisticated numeric models that entail model validation and reiterative processing of data to drive the modeled results. As such the ability of these models to accurately predict chemical transport under the Site conditions may not be well understood. Given the uncertainty inherent in these models they are usually designed with conservative assumptions and are likely to over predict exposure to Site related chemicals.

6.4 EXPOSURE ASSESSMENT

The exposure assessment relied on a number of assumptions for potential human exposure. Assumptions used were based upon the following:

- Site specific information
- USEPA risk assessment guidances
- Professional judgement

The CTE scenarios represent assumptions which are considered central values or realistically conservative estimates for the exposed population. However even the CTE scenarios assume individuals are exposed on a relatively continuous basis over a long period of time which likely over estimates actual exposures.

The RME scenarios are developed to provide an upper bound risk estimate. These scenarios are based on a combination of maximum exposure assumptions for exposure variables and are thus highly likely to over estimate potential risks.

Both CTE and RME exposure scenarios provide useful information when characterizing site risks and when making site management decisions.

6.5 TOXICITY ASSESSMENT

In general the available scientific information is insufficient to provide a thorough understanding of all the potential toxic properties of chemicals to which humans may be exposed. Consequently varying degrees of uncertainty surround the assessment of adverse health effects in the exposed populations. Sources of uncertainty related directly to toxicity data include:

- Use of dose response data from experiments on homogeneous sensitive animal populations to predict effects in heterogeneous human populations with a wide range of sensitivities
- Extrapolation of data from 1) high dose animal studies to low dose human exposures
2) acute or subchronic toxicity studies to chronic exposure scenarios and 3) one exposure route to another (e.g. from ingestion to dermal absorption)
- Use of single chemical test data that do not account for multiple exposures or synergistic and antagonistic responses

- Toxicity values (RfDs or SFs) are predicted values and have incorporated factors to provide a margin of safety for even the most sensitive subpopulations and likely over-estimate potential risks for all receptors evaluated in this risk assessment

Based on the above a high degree of uncertainty may be associated with the toxicity values used in this risk assessment In an attempt to minimize the consequences of uncertainty USEPA typically relies on a conservative approach in determining toxicity values The current USEPA toxicity values used in this risk assessment are likely to over-estimate the potential risk and hazard

6.6 RISK CHARACTERIZATION

Several background chemicals were found at the Site at levels exceeding their respective health based screening levels These included inorganic compounds which are often present as naturally occurring compounds and organic compounds (PAHs) which are present in many urban areas as anthropogenic (man made) background As discussed in USEPA's guidance on evaluation of background chemicals (USEPA 2002b) these chemicals were retained in the risk assessment as COPCs whenever the screening values were exceeded In the case of inorganic compounds quantitative risk values were not calculated if the COPCs exceeded screening levels but were present at background levels However risks were calculated for inorganic COPCs if both screening levels and background levels were exceeded In the case of organic COPCs risks were calculated whenever screening concentrations were exceeded regardless of whether the chemicals were present at background levels Inclusion of background chemicals in the risk calculations will tend to overestimate Site-related risks and hazards since the incremental risks associated with the background level has been included in the overall calculation Exclusion of inorganic chemicals present at background levels will result in an underestimation of total risks but will not affect the Site related risk estimates since these chemicals are not Site related

It should be noted that in general the risks associated with background chemicals are relatively low usually in the 10^{-6} to 10^{-5} range Arsenic is an exception The Site specific background concentration for arsenic is 13.22 mg/kg At this concentration the estimated cancer risk to a residential receptor is 4×10^{-5} and the hazard index is 0.6

Because there are uncertainties in each step of the risk assessment process these uncertainties are often magnified in the final risk characterization The final quantitative estimates of risk may be one or several orders of magnitude different from the actual potential risk associated with a given exposure Because of the conservative approaches used in each step the overall results of this risk assessment are most likely to over estimate the potential Site risks

The HHRA for SLAAP evaluated potential risks and hazards for soils and groundwater for several alternative land use scenarios in support of the FOST process. Alternative scenarios evaluated included trespassers, commercial/industrial workers, excavation workers, and hypothetical future residents. Cancer risks and hazard indices were calculated for numerous exposure areas and hotspots across the Site as well as on a Site wide basis for both RME (high-end) and CTE (mid-range) conditions.

For soils at most areas of the Site and for Site wide groundwater the RME cancer risks were within or below the target risk range of 10^{-4} to 10^{-6} identified in the National Oil and Hazardous Substances Pollution Contingency Plan (USEPA 1990) and most hazard indices were below the threshold of 1. The CTE cancer risks and hazard indices were even lower.

Areas found to exceed a cancer risk of 10^{-4} or hazard index of 1 are listed below:

- Building 2 An RME hazard index of 3 was calculated for a hypothetical future resident. Aroclor 1248³ was the primary contributor to this elevated hazard index. The CTE hazard index for this receptor was 0.4.
- Building 5 An RME hazard index of 6 and a cancer risk of 2×10^{-4} was calculated for a hypothetical future resident. The CTE hazard index was 1 and the CTE cancer risk was 2×10^{-5} . The pesticide DDT was the primary contributor to the hazard index. DDT and benzo(a)pyrene were the primary contributors to the cancer risks. In addition lead was found in surface soils at a 95% UCL of 333 mg/kg which is above the IEUBK based residential action level of 260 mg/kg used by MDNR.
- Hotspot 2 This Hotspot covers the majority of the Building 2 footprint. An RME hazard index of 2 was calculated for a residential scenario. The CTE hazard index was 0.4. Aroclor 1248 was the primary contributor to this hazard index.
- Hotspot 5A This Hotspot covers a small portion of the Building 5 footprint. RME cancer risks were 1×10^{-3} for residents and 3×10^{-4} for industrial/commercial workers. CTE cancer risks were 4×10^{-4} for residents and 2×10^{-5} for industrial/commercial workers. RME Hazard indices were 33 for residents and 3 for industrial/commercial workers. CTE Hazard indices were 15 for residents and 1 for industrial/commercial workers. DDT was the primary contributor to the hazard index. DDT and Aroclor 1248 were the primary contributors to the cancer risks.
- Site wide soils Site wide risks and hazards were calculated by combining soil samples from across the entire Site. The RME hazard index was 6 for the residential scenario and the CTE hazard index was 1. The primary contributors to the elevated hazard index were Aroclor 1248, Aroclor 1254, and DDT. It is important to note that while these risks are defined as Site wide the distribution of these chemicals is relatively limited to a few portions of the Site.

³ The term PCB 1248 and Aroclor 1248 are synonymous terms as are PCB 1254 and Aroclor 1254.

- American Society for Testing and Materials (ASTM) 1996a *ASTM Method 6008 96 Standard Practice for Environmental Baseline Surveys*
- American Society for Testing and Materials (ASTM) 1996b *ASTM Method 1527-97 Standard Practice for Environmental Site Assessments Phase I Environmental Site Assessment Process*
- Arrowhead Contracting 2003 Final Removal Action Report for Building 3 Demolition and PCB TSCA Waste at St Louis Army Ammunition Plant Prepared for the U S Army Corps of Engineers Kansas City District
- Missouri Department of Natural Resources (MDNR) 1993 Letter Regarding Endangered Species and Other Sensitive Environmental Concerns in the Vicinity of the St Louis Army Ammunition Plant (SLAAP) From Dan F Dickneite Planning Division Chief To Larry E Wright Department of the Army 29 December
- Missouri Department of Natural Resources (MDNR) 2001 Cleanup Levels for Missouri (CALM)
- Tetra Tech EM Inc (TTEMI) 2000 Final Environmental Baseline Survey Report St Louis Army Ammunition Plant St Louis Missouri 28 December
- URS Group Inc (URS) 2002 Sampling and Analysis Plan Site Specific Environmental Baseline Survey St Louis Army Ammunition Plant St Louis Missouri July
- URS Group Inc (URS) 2003 Site Specific Environmental Baseline Survey August
- U S Army Environmental Hygiene Agency (USAEHA) 1993 Preliminary Assessment Screening No 38-26 K19X 93 St Louis Army Ammunition Plant St Louis Missouri January
- U S Army Toxic and hazardous Materials Agency (USATHMA) 1979 Installation Assessment of St Louis Army Ammunition Plant Report No 153 December
- U S Department of Labor (USDL) 1992 Employee Tenure and Occupational Mobility in Early 1990's USDL 92 386
- U S Environmental Protection Agency (USEPA) 1989a Risk Assessment Guidance for Superfund (RAGS) Volume I Human Health Evaluation Part A Interim Final EPA/540/1 89/002
- U S Environmental Protection Agency (USEPA) 1989b Exposure Factors Handbook May
- U S Environmental Protection Agency (USEPA) 1991a Risk Assessment Guidance for Superfund Volume 1 – Human Health Evaluation Manual (Part B Development of Risk based Preliminary Remediation Goals) December
- U S Environmental Protection Agency (USEPA) 1991b Standard Default Exposure Factors OSWER Directive 9285 6-03 March
- U S Environmental Protection Agency (USEPA) 1992 Supplemental Guidance to RAGS Calculating the Concentration Term OSWER Publication 9285 7 081

- U S Environmental Protection Agency (USEPA) 1994 Guidance on Residential Lead Based paint lead-contaminated dust and lead contaminated soil Guidance from Lynn R Goldman Assistant Administrator Office of Prevention Pesticides and Toxic Substances July
- U S Environmental Protection Agency (USEPA) 1996 Technical Review Workgroup for Lead
- U S Environmental Protection Agency (USEPA) 1997a Exposure Factors Handbook August
- U S Environmental Protection Agency (USEPA) 1997b The Lognormal Distribution in Environmental Applications December
- U S Environmental Protection Agency (USEPA) 1997c Health Effects Assessment Summary Tables FY 1997 Update
- U S Environmental Protection Agency (USEPA) 1999 Derivation of a Volatilization Factor to Estimate Upper Bound Exposure Point Concentration for Workers in Trenches Flooded with Groundwater off gassing Volatile Organic Compounds Memo from Helen Dawson to Tracy Eagle USEPA Region VIII July
- U S Environmental Protection Agency (USEPA) 2001a Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites Peer Review Draft OSWER 9355 4 24 March
- U S Environmental Protection Agency (USEPA) 2001b Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual Part E Supplemental Guidance for Dermal Risk Assessment Review Draft OSWER 9285 7 02EP September
- U S Environmental Protection Agency (USEPA) 2002a USEPA Region IX Preliminary Remediation Goals (PRGs) October 1
- U S Environmental Protection Agency (USEPA) 2002b Role of Background in the CERCLA Cleanup Program OSWER 9285 6 07P April
- U S Environmental Protection Agency (USEPA) 2002c Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites OSWER 9285 6 10 December
- U S Environmental Protection Agency (USEPA) 2003a Integrated Risk Information System (IRIS) on line database
- U S Environmental Protection Agency (USEPA) 2003b User s Guide for Evaluating Subsurface Vapor Intrusion Into Buildings June 19

Tables

Table 3 1
Exposure Areas Evaluated in the HHRA
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

EXPOSURE AREA	
Focused Hotspot Areas	Systematic Risk Assessment Areas
Building 1 hotspot A (1A)	Building 1
Building 1 hotspot B (1B)	Building 2
Building 1 hotspot C (1C)	Building 4
Building 2 hotspot (2)	Building 5
Building 4 hotspot A (4A)	Building 6
Building 4 hotspot B (4B)	Building 7
Building 4 hotspot C (4C)	Building 8
Building 4 hotspot D (4D)	Northeast Parking Area
Building 5 hotspot A (5A)	Railroads
Building 5 hotspot B (5B)	Roadways
Building 6 hotspot (6)	
Building 7 hotspot A (7A)	Combined Data points
Building 7 hotspot B (7B)	Site Wide
Building 7 hotspot C (7C)	
Building 8 hotspot A (8A)	
Building 8 hotspot B (8B)	
Northeast Parking Area hotspot (NE)	
Roadways hotspot A (RDA)	
Roadways hotspot B (RDB)	
Roadways hotspot C (RDC)	
Railroad hotspot (RR)	
Sewer Line hotspot A (SEA)	
Sewer Line hotspot B (SEB)	

TABLE 3 2
Exposure Parameters
Human Health Risk Assessment
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Future Excavation/ Construction Worker		Future Worker		Current Trespasser		Hypothetical Future Resident	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure Frequency (days/year)	30	60	250	250	6	12	350	350
Exposure Duration (years)	1	1	5	25	9	30	6/3 ^a	6/24 ^a
Incidental Soil Ingestion Rate (mg/day)	100	330	50	100	50	100	100/50	200/100
Incidental Groundwater Ingestion Rate (ml/day)	1	2						
Body Weight (kg)	70	70	70	70	70	70	15/70 ^a	15/70 ^a
Averaging Time for Non Carcinogens (days)	42	84	1 825	9 125	3 285	10 950	2 190	2 190
Averaging Time for Carcinogens (days)	25 550	25 550	25 550	25 550	25 550	25 550	25 550	25 550
Area of Exposed Skin (cm ²)	2 000	3 300	2 000	3 300	2 000	3 300	1440/2000 ^a	1913/3300 ^a
Exposure Time (hours/day)	2	4						
Inhalation Rate (m ³ /hour)	1.3	2.05						
Permeability Constant (cm/hr)			chemical specific					
Dermal Soil Adherence Factor (mg/cm ²)	0.2	0.9	0.03	0.2	0.04	0.3	0.04	0.3
Dermal Absorption Factor (unitless)					chemical specific			

^a Residential exposure is evaluated using a combined child/adult scenario for cancer effects child only for non cancer effects

Table 4 1
Toxicity Values for Chemicals of Potential Concern
Human Health Risk Assessment
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Chemical	Permeability Constant (cm/hr)	Dermal Absorption (unitless)	Slope Factor		Chronic Reference Dose		Subchronic Reference Dose	
			Oral (mg/kg-day)	Inhalation (mg/kg-day) ¹	Oral (mg/kg-day)	Inhalation (mg/kg-day)	Oral (mg/kg-day)	Inhalation (mg/kg-day)
Aroclor 1248	NA	1 4E 1	2/1 ⁶	IRIS	NA	NTV	NA	NTV
Aroclor 1254	NA	1 4E 1	2/1 ⁶	IRIS	NA	2 0E 5	IRIS	5 0E 5 HEAST
Benzo(a)anthracene	4 7E 1	1 3E 1	7 3E 1	NCEA	NA	NTV	NA	NTV
Benzo(a)pyrene	7 0E 1	1 3E 1	7 3E+0	IRIS	NA	NTV	NA	NTV
Benzo(b)fluoranthene	7 0E 1	1 3E 1	7 3E 1	NCEA	NA	NTV	NA	NTV
Benzo(k)fluoranthene	7 0E 1	1 3E 1	7 3E 2	NCEA	NA	NTV	NA	NTV
Carbon Tetrachloride	1 6E 2	NA	1 3E 1	IRIS	5 3E 2	IRIS	7 0E-4	IRIS
Chloroform	6 8E 3	0	NTV	NTV		1 0E 2	IRIS	8 6E-4 NCEA
Chrysene	4 7E 1	NA	7 3E 3	IRIS	NA	NTV	NA	NTV
DDE	NA	3 0E 2	3 4E 1	IRIS	NA	5 0E-4	DDT	5 0E-4 DDT
DDT	NA	3 0E 2	3 4E 1	IRIS	NA	5 0E-4	IRIS	5 0E-4 IRIS
1,1 Dichloroethene	1 2E 2	0	NTV	NTV		5 0E 2	IRIS	5 0E 2
Dibenzo(a,h)anthracene	1 5E+0	1 3E 1	7 3E+0	NCEA	NA	NTV	NA	NTV
1,2 Dichloroethane	4 2E 3	0	9 1E 2	IRIS	9 1E 2	IRIS	3 0E 2	NCEA
1,2 Diphenylhydrazine	1 3E 2	NA	8 0E 1	IRIS	NA	NTV	NA	NTV
Indeno(1,2,3-cd)pyrene	1 0E+0	1 3E 1	7 3E 1	NCEA	NA	NTV	NA	NTV
Polychlorinated biphenyls	NA	1 4E 1	2/1 ⁶	IRIS	NA	NTV	NA	NTV
TCDD	NA	3 0E 2	1 5E+5	HEAST	NA	NTV	NTV	NTV
Total Aroclors	NA	1 4E 1	2/1 ⁶	IRIS	NA	NTV	NA	NTV
Antimony	NA	0	NTV	NA		4 0E-4	IRIS	4 0E-4 HEAST
Arsenic ²	1 0E 3	3 0E 2	1 5E+0	IRIS	NA	3 0E-4	IRIS	3 0E-4 HEAST
Barium	NA	0	NTV	NA		7 0E 2	IRIS	7 0E 2 HEAST
Beryllium	NA	0	NTV	NA		2 0E 3	IRIS	5 0E 3 HEAST
Cadmium	NA	1 0E 3	NTV	NA		5 0E-4	IRIS	NTV
Chromium ³	NA	0	NTV	NA		3 0E 3	IRIS	2 0E 2 HEAST
Copper	NA	0	NTV	NA		4 0E 2	HEAST	4 0E 2 HEAST
Lead ⁵	NA	0	NTV	NA		NTV	NA	NTV
Mercury ⁷	NA	0	NTV	NA		3 0E-4	IRIS	3 0E 3 HEAST

NTV indicates that no toxicity value was found for that chemical of concern

NA indicates that the exposure pathway is not applicable to this risk evaluation

¹Oral reference dose is for metallic antimony

²Oral reference dose is for inorganic arsenic

³Oral reference dose is for chromium VI salt

⁴Route to route extrapolation from oral value

⁵EPA does not supply toxicity values for lead. Lead is evaluated using the IEUBK model for children or the adult lead model for adults

⁶Slope Factor for polychlorinated biphenyls is dependent on exposure pathway. For relevant pathways at SLAAP RME SF is 2 0 CTE SF is 1 0

⁷Oral reference dose is for mercuric chloride

Table 5 1
 Potential Risks and Hazards for Excavation/Construction Workers
 Surface and Subsurface Soils
 St Louis Army Ammunition Plant (SLAAP)
 St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 0023	3 1E 9	0 014	4 8E 8
Building 2	0 015	1 0E 8	0 17	1 8E 7
Building 4	0 0014	1 8E 9	0 0054	2 7E 8
Building 5	0 085	4 4E 8	0 85	9 5E 7
Building 6	0 0036	5 9E 10	0 024	1 1E 8
Building 7	0 0047	6 6E 9	0 023	1 0E 7
Building 8	0 0010	2 2E 9	0 0034	2 8E 8
Northeast Parking Area	0	3 9E 9	0	6 8E 8
Railroads	0 0014	6 9E 10	0 0050	8 1E 9
Roadways	0 024	2 1E 9	0 085	2 5E 8
Combined Data points				
Site Wide	0 10	3 8E 8	0 68	5 0E 7
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 0032	2 7E 10	0 031	1 0E 8
Building 1 hotspot B (1B)	0 0069	9 5E 9	0 060	2 1E 7
Building 1 hotspot C (1C)	0 035	2 6E 8	0 20	3 0E 7
Building 2 hotspot (2)	0 018	1 8E 8	0 17	2 4E 7
Building 4 hotspot A (4A)	0 0015	8 5E 9	0 006	1 9E 7
Building 4 hotspot B (4B)	0 0014	3 2E 8	0 0054	9 4E 7
Building 4 hotspot C (4C)	0	7 7E 9	0	1 4E 7
Building 4 hotspot D (4D)	0 0019	0 0E+0	0 0076	0 0E+0
Building 5 hotspot A (5A)	1 3	6 7E 7	8 0	9 9E 6
Building 5 hotspot B (5B)	0	1 5E 8	0	3 3E 7
Building 6 hotspot (6)	0 0033	4 8E 10	0 021	8 6E 9
Building 7 hotspot A (7A)	0 0046	1 4E 8	0 025	2 8E 7
Building 7 hotspot B (7B)	0 00015	8 4E 10	0 00088	1 3E 8
Building 7 hotspot C (7C)	0 0019	2 4E 9	0 0071	6 0E 8
Building 8 hotspot A (8A)	0	7 0E 9	0	1 5E 7
Building 8 hotspot B (8B)	0	3 4E 9	0	5 8E 8
Northeast Parking Area hotspot (NE)	0	1 7E 8	0	4 5E 7
Roadways hotspot A (RDA)	0	1 1E 8	0	2 7E 7
Roadways hotspot B (RDB)	0 036	1 7E 9	0 29	3 9E 8
Roadways hotspot C (RDC)	0 0020	0 0E+0	0 0081	0 0E+0
Railroad hotspot (RR)	0 0019	0	0 0090	0
Sewer Line hotspot A (SEA)	0	3 0E 8	0	5 5E 7
Sewer Line hotspot B (SEB)	0	3 4E 9	0	3 2E 8

Table 5 2
Potential Risks and Hazards for Industrial/Commercial Workers
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 0051	8 3E 8	0 018	2 9E 6
Building 2	0 034	2 8E 7	0 31	9 0E 6
Building 4	0 0036	0 0E+0	0 0092	0 0E+0
Building 5	0 079	1 5E 6	0 48	5 4E 5
Building 6	0 0010	2 2E 9	0 0034	5 1E 8
Building 7	0 0072	2 8E 7	0 022	8 1E 6
Building 8	0	1 4E 8	0	3 6E 7
Northeast Parking Area	0	8 8E 8	0	3 0E 6
Railroads	0	1 1E 8	0	3 1E 7
Roadways	0 016	3 6E 8	0 036	8 4E 7
Combined Data points				
Site Wide	0 11	1 1E 6	0 56	2 6E 5
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 010	1 4E 8	0 033	4 7E 7
Building 1 hotspot B (1B)	0 013	4 0E 7	0 046	9 0E 6
Building 1 hotspot C (1C)	0 018	5 8E 7	0 055	8 8E 6
Building 2 hotspot (2)	0 034	3 7E 7	0 23	8 9E 6
Building 4 hotspot A (4A)	0	3 2E 7	0	5 1E 6
Building 4 hotspot B (4B)	0 0051	9 9E 7	0 010	2 6E 5
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 0048	0 0E+0	0 011	0 0E+0
Building 5 hotspot A (5A)	1 2	2 4E 5	2 8	3 2E 4
Building 5 hotspot B (5B)	0	8 8E 8	0	1 4E 6
Building 6 hotspot (6)	0 0015	4 7E 9	0 0058	1 3E 7
Building 7 hotspot A (7A)	0 0075	4 7E 7	0 026	1 5E 5
Building 7 hotspot B (7B)	0	2 1E 8	0	3 4E 7
Building 7 hotspot C (7C)	0 0051	1 0E 7	0 010	1 6E 6
Building 8 hotspot A (8A)	0	3 2E 8	0	1 0E 6
Building 8 hotspot B (8B)	0	5 3E 8	0	8 5E 7
Northeast Parking Area hotspot (NE)	0	7 6E 7	0	1 2E 5
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 042	6 5E 8	0 083	1 0E 6
Roadways hotspot C (RDC)	0 0065	0 0E+0	0 015	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

No COPCs were identified in surface soils in these areas

Table 5-3
Potential Risks and Hazards for Trespassers/Site Visitors
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 00012	3 8E 9	0 00085	2 0E 7
Building 2	0 00086	1 2E 8	0 018	6 0E 7
Building 4	0 000086	0 0E+0	0 00044	0 0E+0
Building 5	0 0019	6 6E 8	0 025	3 6E 6
Building 6	0 000025	9 7E 11	0 00016	3 2E 9
Building 7	0 00018	1 3E 8	0 0012	5 8E 7
Building 8	0	6 5E 10	0	2 5E 8
Northeast Parking Area	0	4 0E 9	0	2 1E 7
Railroads	0	4 9E 10	0	2 2E 8
Roadways	0 00038	1 6E 9	0 0017	5 9E 8
Combined Data points				
Site Wide	0 0025	4 6E 8	0 031	1 7E 6
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 00025	6 5E 10	0 0020	3 4E 8
Building 1 hotspot B (1B)	0 00032	1 8E 8	0 0022	6 4E 7
Building 1 hotspot C (1C)	0 00044	2 6E 8	0 0028	5 5E 7
Building 2 hotspot (2)	0 00086	1 6E 8	0 013	5 8E 7
Building 4 hotspot A (4A)	0	1 4E 8	0	3 6E 7
Building 4 hotspot B (4B)	0 00012	4 5E 8	0 00049	1 8E 6
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 00012	0 0E+0	0 00052	0 0E+0
Building 5 hotspot A (5A)	0 029	1 0E 6	0 14	2 1E 5
Building 5 hotspot B (5B)	0	4 0E 9	0	1 0E 7
Building 6 hotspot (6)	0 000035	2 0E 10	0 00029	8 1E 9
Building 7 hotspot A (7A)	0 00018	2 1E 8	0 0014	1 1E 6
Building 7 hotspot B (7B)	0	9 6E 10	0	2 4E 8
Building 7 hotspot C (7C)	0 00012	4 5E 9	0 00049	1 1E 7
Building 8 hotspot A (8A)	0	1 5E 9	0	7 1E 8
Building 8 hotspot B (8B)	0	2 4E 9	0	6 0E 8
Northeast Parking Area hotspot (NE)	0	3 4E 8	0	8 6E 7
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 0010	2 9E 9	0 0040	7 4E 8
Roadways hotspot C (RDC)	0 00015	0 0E+0	0 00074	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

No COPCs were identified in surface soils in these areas

Table 5 4
Potential Risks and Hazards for Hypothetical Future Residents
Surface Soils
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Exposure Area	Central Tendency Exposure (CTE)		Reasonable Maximum Exposure (RME)	
	Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Systematic Risk Assessment Areas				
Building 1	0 066	1 3E 6	0 23	1 1E 5
Building 2	0 41	4 5E 6	3 0	3 7E 5
Building 4	0 047	0 0E+0	0 12	0 0E+0
Building 5	1 0	2 4E 5	5 8	2 2E 4
Building 6	0 013	3 6E 8	0 043	2 2E 7
Building 7	0 092	4 4E 6	0 24	3 2E 5
Building 8	0	2 2E 7	0	1 4E 6
Northeast Parking Area	0	1 4E 6	0	1 2E 5
Railroads	0	1 7E 7	0	1 2E 6
Roadways	0 21	5 5E 7	0 46	3 3E 6
Combined Data points				
Site Wide	1 2	1 7E 5	5 9	1 1E 4
Focused Hotspot Areas				
Building 1 hotspot A (1A)	0 12	2 2E 7	0 31	1 9E 6
Building 1 hotspot B (1B)	0 17	6 1E 6	0 60	3 6E 5
Building 1 hotspot C (1C)	0 23	9 5E 6	0 65	3 8E 5
Building 2 hotspot (2)	0 41	6 0E 6	2 2	3 7E 5
Building 4 hotspot A (4A)	0	4 9E 6	0	2 0E 5
Building 4 hotspot B (4B)	0 066	1 5E 5	0 13	1 0E 4
Building 4 hotspot C (4C)				
Building 4 hotspot D (4D)	0 063	0 0E+0	0 14	0 0E+0
Building 5 hotspot A (5A)	15	3 8E 4	33	1 3E 3
Building 5 hotspot B (5B)	0	1 4E 6	0	5 6E 6
Building 6 hotspot (6)	0 019	7 6E 8	0 073	5 6E 7
Building 7 hotspot A (7A)	0 10	7 2E 6	0 29	6 1E 5
Building 7 hotspot B (7B)	0	3 3E 7	0	1 4E 6
Building 7 hotspot C (7C)	0 066	1 5E 6	0 13	6 4E 6
Building 8 hotspot A (8A)	0	5 0E 7	0	4 0E 6
Building 8 hotspot B (8B)	0	8 2E 7	0	3 4E 6
Northeast Parking Area hotspot (NE)	0	1 2E 5	0	4 8E 5
Roadways hotspot A (RDA)				
Roadways hotspot B (RDB)	0 54	1 0E 6	1 1	4 1E 6
Roadways hotspot C (RDC)	0 084	0 0E+0	0 20	0 0E+0
Railroad hotspot (RR)				
Sewer Line hotspot A (SEA)				
Sewer Line hotspot B (SEB)				

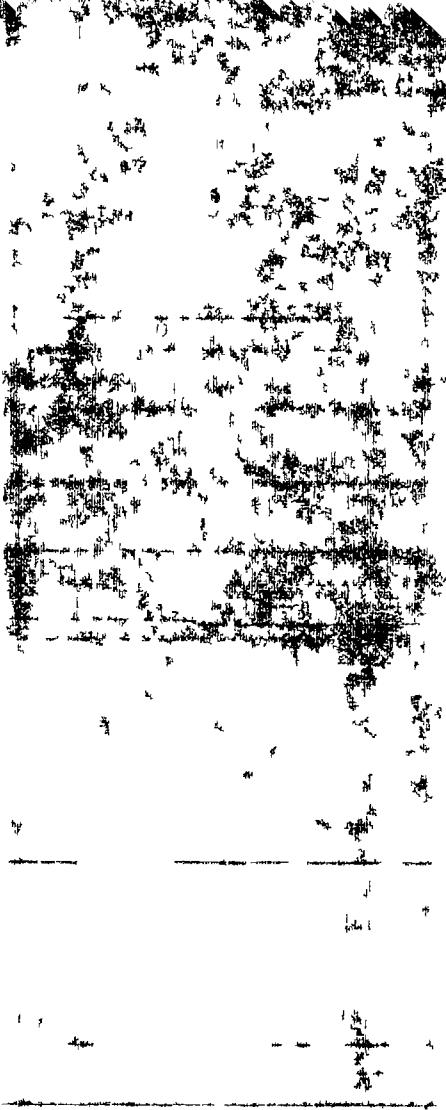
No COPCs were identified in surface soils in these areas

Table 5 5
Potential Risks and Hazards Associated With Vapor Intrusion Into Buildings
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Chemical	Hazard Index	Cancer Risk
1,1 Dichloroethene	0.011	NA
1,2 Dichloroethane	NA	1.40E-08
Carbon tetrachloride	NA	3.70E-07
Chloroform	NA	1.00E-06
TOTAL	0.011	1.4E-06

Table 5 6
Potential Risks and Hazards for Excavation/Construction Workers
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Central Tendency Hazard Index	Exposure (CTE) Cancer Risk	Reasonable Maximum Exposure (RME) Hazard Index	Cancer Risk
0 0078	1 0E 7	0 025	6 6E 7



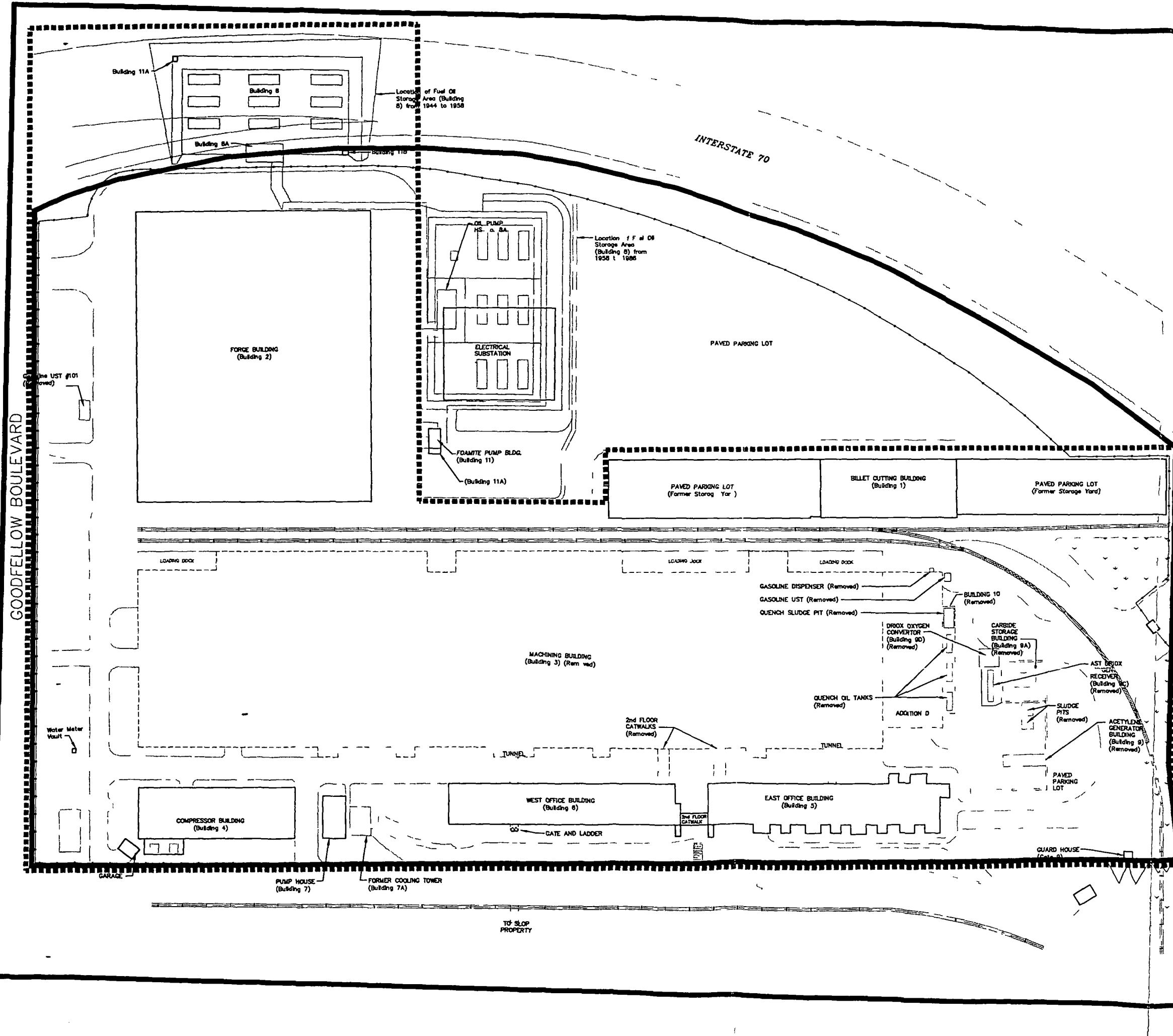
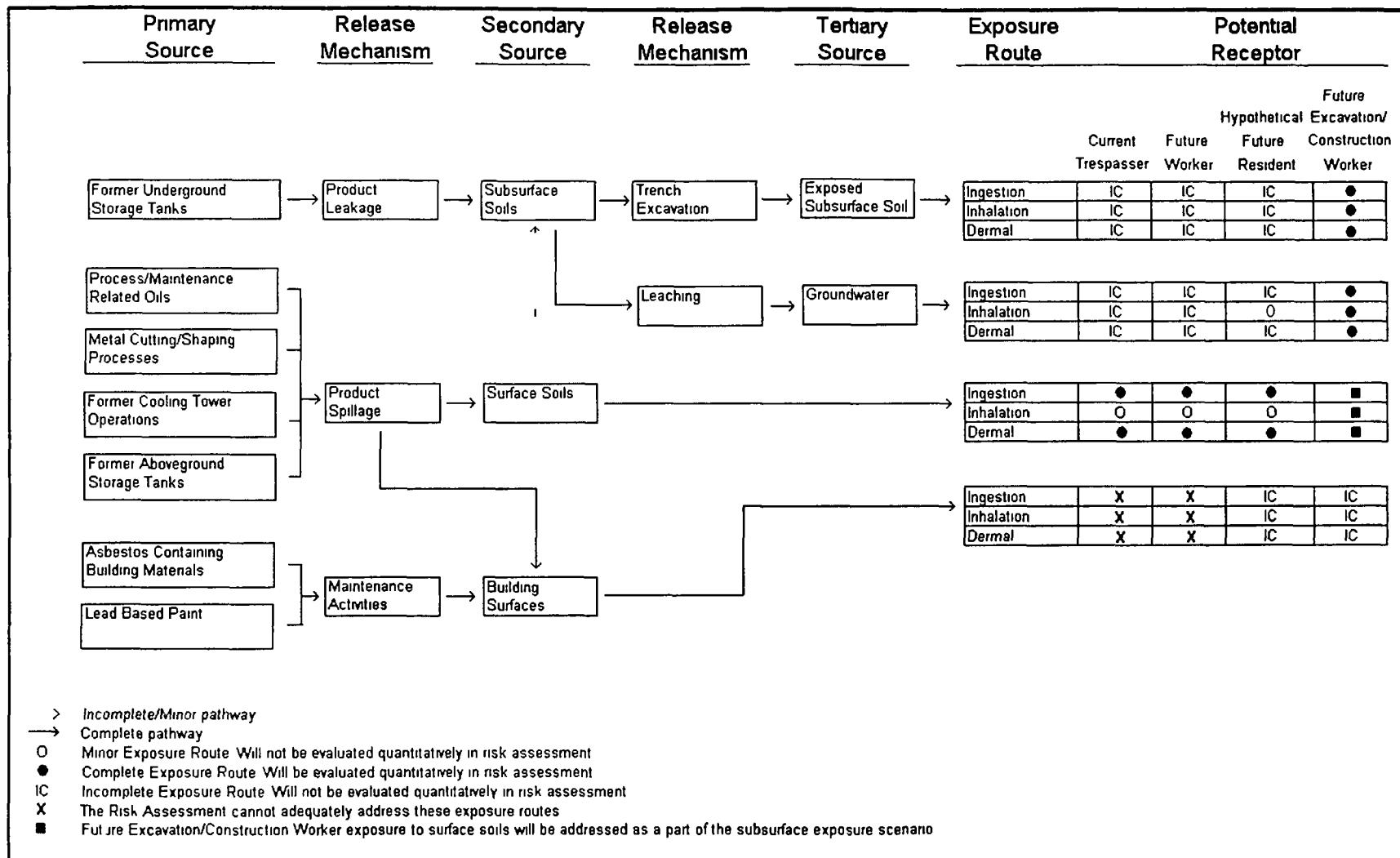


Figure 3 1
Site Conceptual Exposure Model
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri



- > Incomplete/Minor pathway
- Complete pathway
- O Minor Exposure Route Will not be evaluated quantitatively in risk assessment
- Complete Exposure Route Will be evaluated quantitatively in risk assessment
- IC Incomplete Exposure Route Will not be evaluated quantitatively in risk assessment
- X The Risk Assessment cannot adequately address these exposure routes
- Future Excavation/Construction Worker exposure to surface soils will be addressed as a part of the subsurface exposure scenario

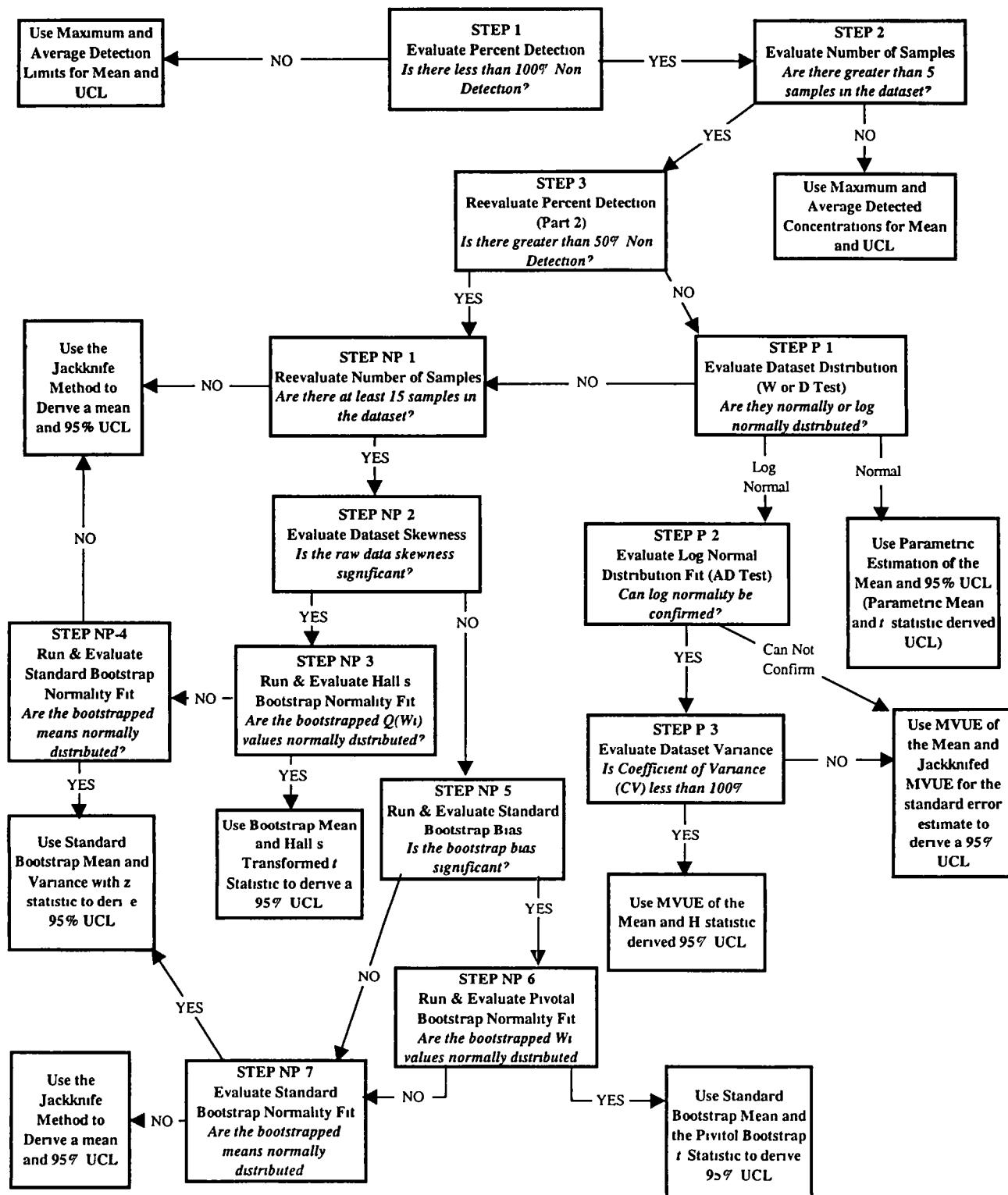
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Figure 3 4
Logic Diagram for Non parametric Statistical Analyses
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri



ATTACHMENT A

Risk Calculation Spreadsheets

Attachment A 1-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 1 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	1 5	8 7	10/10	6 2	5	0 03	NE	NE	13 22
Beryllium	mg/kg	0 12	0 63	10/10	0 61	0 49	0	NE	NE	1 01
Chromium	mg/kg	5	46	10/10	26 9	20 7	0	3 0E-03	NTV	25 46
Copper	mg/kg	1 6	1260	10/10	368	140	0	4 0E 02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 003	1 7	7/10	0 74	0 33	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 004	1 2	7/10	0 31	0 14	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 005	1 7	7/10	0 66	0 31	0 13	NTV	0 73	0 63
Dibenz(a,h)anthracene	mg/kg	0 003	0 29	4/10	0 107	0 057	0 13	NTV	7 3	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 002	0 7	7/10	0 45	0 21	0 13	NTV	0 73	0 41

Building 1 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{rel} (mg/kg-day) ¹	Background
Arsenic	mg/kg	1 5	8 7	30/30	5 4	4 8	0 03	NE	NE	13 22
Beryllium	mg/kg	0 087	0 69	30/30	0 55	0 54	0	NE	NE	1 01
Chromium	mg/kg	5	46	30/30	21 6	18 7	0	2 0E-02	NTV	25 46
Copper	mg/kg	1 6	1260	30/30	125	54	0	4 0E-02	NTV	59 1
Benzo(a)anthracene	mg/kg	0 002	1 7	20/30	0 28	0 17	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 003	1 2	16/30	0 15	0 085	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 001	1 7	18/30	0 26	0 16	0 13	NTV	0 73	0 63
Dibenz(a,h)anthracene	mg/kg	0 003	0 29	5/30	0 053	0 038	0 13	NTV	7 3	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 001	0 7	17/30	0 18	0 11	0 13	NTV	0 73	0 41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-1-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	21.6	1E 6	0.9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Copper	125	1E 6	0.9	0	3 300	60	1	70	84	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0.28	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.6E 9
Benzo(a)pyrene	0.15	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.4E 8
Benzo(b)fluoranthene	0.26	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.5E 9
Dibenz(a,h)anthracene	0.053	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	5.0E 9
Indeno(1,2,3 cd)pyrene	0.18	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.7E 9
Total													0 0E+0	2.6E 8

Attachment A-1-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

R_{fD_{oral}} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	21.6	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	3.6E 3	NA
Copper	125	1E 6	330	60	1	70	84	25 550	4 0E 02	NTV	1.1E 2	NA
Benzo(a)anthracene	0.28	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.3E 9
Benzo(a)pyrene	0.15	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.2E 8
Benzo(b)fluoranthene	0.26	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.1E 9
Dibenz(a h)anthracene	0.053	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	4.3E 9
Indeno(1 2 3 cd)pyrene	0.18	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.5E 9
Total										1.4E 2	2.2E 8	

Attachment A-1-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	18.7	1E 6	0.2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0.0E+0	NA
Copper	54	1E 6	0.2	0	2 000	30	1	70	42	25 550	4 0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.17	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	1.1E 10
Benzo(a)pyrene	0.085	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	5.4E 10
Benzo(b)fluoranthene	0.16	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	1.0E 10
Dibenz(a h)anthracene	0.038	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.4E 10
Indeno(1 2 3 cd)pyrene	0.11	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	7.0E 11
Total													0.0E+0	1.1E 9

Attachment A-1-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	18.7	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	9.5E 4	NA
Copper	54	1E 6	100	30	1	70	42	25 550	4.0E 02	NTV	1.4E 3	NA
Benzo(a)anthracene	0.17	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.1E 10
Benzo(a)pyrene	0.085	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.0E 9
Benzo(b)fluoranthene	0.16	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.0E 10
Dibenz(a h)anthracene	0.038	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	4.7E 10
Indeno(1 2 3 cd)pyrene	0.11	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.3E 10
Total										2.3E 3	2.0E 9	

Attachment A-1-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	26.9	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 03	NTV	0.0E+0	NA
Copper	368	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.74	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.6E 7
Benzo(a)pyrene	0.31	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	6.8E 7
Benzo(b)fluoranthene	0.66	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.4E 7
Dibenz(a,h)anthracene	0.107	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.3E 7
Indeno(1,2,3 cd)pyrene	0.45	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	9.8E 8
Total												0.0E+0	1.3E 6	

Attachment A-1-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	26.9	1E 6	100	250	25	70	9 125	25 550	3.0E 03	NTV	8.8E 3	NA
Copper	368	1E 6	100	250	25	70	9 125	25 550	4.0E 02	NTV	9.0E 3	NA
Benzo(a)anthracene	0.74	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.9E 7
Benzo(a)pyrene	0.31	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	7.9E 7
Benzo(b)fluoranthene	0.66	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.7E 7
Dibenz(a h)anthracene	0.107	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.7E 7
Indeno(1 2 3 cd)pyrene	0.45	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.1E 7
Total										1.8E 2	1.5E 6	

Attachment A-1-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT	RfD _{oral}	SF	Hazard Index	Cancer Risk
Chromium	20.7	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 03	NTV	0.0E+0	NA
Copper	140	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.33	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	1.3E 9
Benzo(a)pyrene	0.14	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	5.6E 9
Benzo(b)fluoranthene	0.31	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	1.2E 9
Dibenz(a,h)anthracene	0.057	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.3E 9
Indeno(1,2,3 cd)pyrene	0.21	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	8.4E 10
Total													0.0E+0	1.1E 8

Attachment A-1-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20.7	1E 6	50	250	5	70	1 825	25 550	3.0E 03	NTV	3.4E 3	NA
Copper	140	1E 6	50	250	5	70	1 825	25 550	4.0E 02	NTV	1.7E 3	NA
Benzo(a)anthracene	0.33	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	8.4E 9
Benzo(a)pyrene	0.14	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	3.6E 8
Benzo(b)fluoranthene	0.31	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	7.9E 9
Dibenz(a h)anthracene	0.057	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.5E 8
Indeno(1 2 3 cd)pyrene	0.21	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	5.4E 9
Total											5.1E 3	7.2E 8

Attachment A-1-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{nc} \text{ RfD}_{oral})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_{D_{oral}} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{\text{oral}}) / (BW \ AT_c)$$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day^1)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	26.9	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0.0E+0	NA
Copper	368	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	4 0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.74	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.4E 8
Benzo(a)pyrene	0.31	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	5.9E 8
Benzo(b)fluoranthene	0.66	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.2E 8
Dibenz(a h)anthracene	0.107	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.0E 8
Indeno(1 2 3 cd)pyrene	0.45	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	8.5E 9
												Total	0.0E+0	1.1E 7

Attachment A-1-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	26.9	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4.2E 4	NA
Copper	368	1E 6	100	12	30	70	10 950	25 550	4 0E 02	NTV	4.3E 4	NA
Benzo(a)anthracene	0.74	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.1E 8
Benzo(a)pyrene	0.31	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	4.6E 8
Benzo(b)fluoranthene	0.66	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	9.7E 9
Dibenz(a h)anthracene	0.107	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.6E 8
Indeno(1 2 3 cd)pyrene	0.45	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	6.6E 9
										Total	8.5E 4	8.8E 8

Attachment A-1-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20.7	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 03	NTV	0.0E+0	NA
Copper	140	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.33	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	7.6E 11
Benzo(a)pyrene	0.14	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	3.2E 10
Benzo(b)fluoranthene	0.31	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	7.1E 11
Dibenz(a,h)anthracene	0.057	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.3E 10
Indeno(1,2,3 cd)pyrene	0.21	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	4.8E 11
Total													0.0E+0	6.5E 10

Attachment A-1-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20.7	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	8 1E 5	NA
Copper	140	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	4 1E 5	NA
Benzo(a)anthracene	0.33	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 6E 10
Benzo(a)pyrene	0.14	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 5E 9
Benzo(b)fluoranthene	0.31	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 4E 10
Dibenz(a h)anthracene	0.057	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	6 3E 10
Indeno(1 2 3 cd)pyrene	0.21	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 3E 10
										Total	1 2E 4	3 1E 9

Attachment A-1 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
 (hazard estimate assumes child only exposure)

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
 (cancer risk assumes child + adult exposure)

Where
 CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Chromium	26.9	1E-6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E 03	NTV	0	NA
Copper	368	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	4.0E 02	NTV	0	NA
Benzo(a)anthracene	0.74	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 01	NA	5.5E 7
Benzo(a)pyrene	0.31	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	2.3E 6
Benzo(b)fluoranthene	0.66	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 01	NA	4.9E 7
Dibenz(a,h)anthracene	0.107	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	7.9E 7
Indeno(1,2,3-cd)pyrene	0.45	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E-01	NA	3.3E 7
Total																0.0E+0	4.5E 6

Attachment A 1 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} \cdot BW_{child}) + (IR_{adult} \cdot ED_{adult} \cdot BW_{adult}))) / (AT_{cancer})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{cancer} = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	26.9	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	1.1E 1	NA
Copper	368	1E 6	200	100	350	6	24	15	70	2 190	25 550	4.0E 02	NTV	1.2E 1	NA
Benzo(a)anthracene	0.74	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	8.5E 7
Benzo(a)pyrene	0.31	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	3.5E 6
Benzo(b)fluoranthene	0.66	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	7.5E 7
Dibenz(a,h)anthracene	0.107	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.2E 6
Indeno(1,2,3-cd)pyrene	0.45	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	5.1E 7
Total														2.3E 1	6.9E 6

Attachment A-1 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{rel})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{rel}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Chromium	20.7	1E-6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	0.0E+0	NA
Copper	140	1E-6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4.0E-02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.33	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-8
Benzo(a)pyrene	0.14	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	4.8E-8
Benzo(b)fluoranthene	0.31	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-8
Dibenz(a,h)anthracene	0.057	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	2.0E-8
Indeno(1,2,3-cd)pyrene	0.21	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	7.2E-9
Total																0.0E+0	9.7E-8

Attachment A-1-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_{nc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20.7	1E-6	100	50	350	6	3	15	70	2190	25550	3.0E-03	NTV	4.4E-2	NA
Copper	140	1E-6	100	50	350	6	3	15	70	2190	25550	4.0E-02	NTV	2.2E-2	NA
Benzo(a)anthracene	0.33	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	1.4E-7
Benzo(a)pyrene	0.14	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	5.9E-7
Benzo(b)fluoranthene	0.31	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	1.3E-7
Dibenz(a,h)anthracene	0.057	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	2.4E-7
Indeno(1,2,3-cd)pyrene	0.21	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	8.9E-8
Total														6.6E-2	1.2E-6

Attachment A-1-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 1 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 1E 9	2 6E 8
Ingestion	0 0023	0 014	2 0E 9	2 2E 8
Total	<u>0 0023</u>	<u>0 014</u>	<u>3 1E 9</u>	<u>4 8E 8</u>
Future Industrial/Commercial Worker				
Dermal	0	0	1 1E 8	1 3E 6
Ingestion	0 0051	0 018	7 2E 8	1 5E 6
Total	<u>0 0051</u>	<u>0 018</u>	<u>8 3E 8</u>	<u>2 9E 6</u>
Current Trespasser/Site Visitor				
Dermal	0	0	6 5E 10	1 1E 7
Ingestion	0 00012	0 00085	3 1E 9	8 8E 8
Total	<u>0 00012</u>	<u>0 00085</u>	<u>3 8E 9</u>	<u>2 0E 7</u>
Hypothetical Future Resident				
Dermal	0	0	9 7E 8	4 5E 6
Ingestion	0 066	0 23	1 2E 6	6 9E 6
Total	<u>0 066</u>	<u>0 23</u>	<u>1 3E 6</u>	<u>1 1E 5</u>

Attachment A-2 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 2 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	1 79E 06	1 13E 04	7/7	7 25E 05	4 24E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0081	14	6/12	3 3	1 2	0 14	2 0E 05	2/1	
Arsenic	mg/kg	4 2	8 7	12/12	6 8	6 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 44	0 77	12/12	0 64	0 59	0	NE	NE	1 01
Lead	mg/kg	10	721	12/12	180	73 9	0	NE	NE	363

Building 2 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	1 58E 06	1 13E 04	15/15	5 52E 05	3 07E 05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0074	14	14/36	1 11	0 46	0 14	5 0E-05	2/1	
Arsenic	mg/kg	1 8	8 9	36/36	6 4	6	0 03	NE	NE	13 22
Beryllium	mg/kg	0 44	0 97	36/36	0 68	0 64	0	NE	NE	1 01
Lead	mg/kg	7 7	721	36/36	68	35	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0 003	0 17	12/36	0 044	0 029 ²	0 13	NTV	7 3E+00	0 74

¹Present at background level

Lead has no RfD or SF and is evaluated separately

The RfD for PCB 1254 is used to evaluate hazard for PCB 1248

IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-2-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5 52E 05	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1 5E+05	NA	2 5E 8
PCB 1248	1 11	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 4E 2	3 1E 8
Benzo(a)pyrene	0 044	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	4 2E 9
													Total	9 4E 2
														6 0E 8

Attachment A-2-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5.52E-05	1E-6	330	60	1	70	84	25 550	NTV	1.5E+05	NA	9.2E-8
PCB 1248	1.11	1E-6	330	60	1	70	84	25 550	5.0E-05	2.0E+00	7.5E-2	2.5E-8
Benzo(a)pyrene	0.044	1E-6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	3.6E-9
										Total	7.5E-2	1.2E-7

Attachment A-2-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3.07E-05	1E-6	0.2	0.03	2.000	30	1	70	42	25.550	NTV	1.5E+05	NA	9.3E-10
PCB 1248	0.46	1E-6	0.2	0.14	2.000	30	1	70	42	25.550	5.0E-05	1.0E+00	5.3E-3	4.3E-10
Benzo(a)pyrene	0.029	1E-6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E+00	NA	1.8E-10
												Total	5.3E-3	1.5E-9

Attachment A-2-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3.07E 05	1E 6	100	30	1	70	42	25 550	NTV	1.5E+05	NA	7.7E 9
PCB 1248	0.46	1E 6	100	30	1	70	42	25 550	5.0E 05	1.0E+00	9.4E 3	7.7E 10
Benzo(a)pyrene	0.029	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	3.6E 10
										Total	9.4E 3	8.9E 9

Attachment A-2-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where ¹ HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	7 25E 05	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	7 5E 7	
PCB 1248	3 3	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 5E 1	2 1E 6	
													Total	1 5E 1	2 9E 6

Attachment A-2-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7 25E 05	1E 6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	3 8E 6
PCB 1248	3 3	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 6E 1	2 3E 6
											Total	1 6E 1
												6 1E 6

Attachment A-2-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	4 24E 05	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	NTV	1 5E+05	NA	8 0E 9	
PCB 1248	1 2	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	4 9E 3	7 0E 9	
													Total	4 9E 3	1 5E 8

Attachment A-2-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	4 24E 05	1E 6	50	250	5	70	1 825	25 550	NTV	1 5E+05	NA	2 2E 7	
PCB 1248	1 2	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 9E 2	4 2E 8	
											Total	2 9E 2	2 6E 7

Attachment A-2-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	7 25E 05	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	NTV	1 5E+05	NA	6 5E 8	
PCB 1248	3 3	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	1 1E 2	1 8E 7	
													Total	1 1E 2	2 5E 7

Attachment A-2-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	7 25E 05	1E 6	100	12	30	70	10 950	25 550	NTV	1 5E+05	NA	2 2E 7	
PCB 1248	3 3	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	7 7E 3	1 3E 7	
											Total	7 7E 3	3 5E 7

Attachment A-2-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	4 24E 05	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	NTV	1 5E+05	NA	4 6E 10
PCB 1248	1 2	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 6E 4	4 1E 10
													Total	1 6E 4
														8 7E 10

Attachment A-2-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	4.24E-05	1E-6	50	6	9	70	3.285	25.550	NTV	1.5E+05	NA	9.6E-9	
PCB 1248	1.2	1E-6	50	6	9	70	3.285	25.550	2.0E-05	1.0E+00	7.0E-4	1.8E-9	
											Total	7.0E-4	1.1E-8

Attachment A-2-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child}/BW_{child}) + (SA_{adult} \cdot ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	7.25E 05	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	1.5E+05	NA	2.5E 6
PCB 1248	3.3	1E 6	0.3	0.14	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E 05	2.0E+00	8.5E 1	7.2E 6
															Total	8.5E 1	9.7E 6

Attachment A-2-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_c \ RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	7.25E-05	1E-6	200	100	350	6	24	15	70	2.190	25.550	NTV	1.5E+05	NA	1.7E-5	
PCB 1248	3.3	1E-6	200	100	350	6	24	15	70	2.190	25.550	2.0E-05	2.0E+00	2.1E+0	1.0E-5	
														Total	2.1E+0	2.7E-5

Attachment A-2-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD	Hazard Index	Cancer Risk	
Dioxin TEQ	4.24E-05	1E-6	0.04	0.03	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	1.5E+05	NA	6.9E-8
PCB 1248	1.2	1E-6	0.04	0.14	1.440	2.000	350	6	3	15	70	2.190	25.550	2.0E-05	1.0E+00	3.1E-2	6.1E-8
															Total	3.1E-2	1.3E-7

Attachment A-2-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_c \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} \ ((IR_{child} \ ED_{child} / BW_{child}) + (IR_{adult} \ ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	4.24E-05	1E-6	100	50	350	6	3	15	70	2.190	25.550	NTV	1.5E+05	NA	3.7E-6	
PCB 1248	1.2	1E-6	100	50	350	6	3	15	70	2.190	25.550	2.0E-05	1.0E+00	3.8E-1	6.9E-7	
														Total	3.8E-1	4.4E-6

Attachment A-2-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0053	0 094	1 5E 9	6 0E 8
Ingestion	0 0094	0 075	8 9E 9	1 2E 7
Total	<u>0 015</u>	<u>0 17</u>	<u>1 0E 8</u>	<u>1 8E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 0049	0 15	1 5E 8	2 9E 6
Ingestion	0 029	0 16	2 6E 7	6 1E 6
Total	<u>0 034</u>	<u>0 31</u>	<u>2 8E 7</u>	<u>9 0E 6</u>
Current Trespasser/Site Visitor				
Dermal	0 00016	0 011	8 7E 10	2 5E 7
Ingestion	0 00070	0 0077	1 1E 8	3 5E 7
Total	<u>0 00086</u>	<u>0 018</u>	<u>1 2E 8</u>	<u>6 0E 7</u>
Hypothetical Future Resident				
Dermal	0 031	0 85	1 3E 7	9 7E 6
Ingestion	0 38	2 1	4 4E 6	2 7E 5
Total	<u>0 41</u>	<u>3 0</u>	<u>4 5E 6</u>	<u>3 7E 5</u>

Attachment A-3 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 4 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	1 1	5 5	10/10	4 8	4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	1 4	10/10	0 88	0 65	0	2 0E 03	NTV	1 01
Chromium	mg/kg	2	36	10/10	27	21	0	3 0E-03	NTV	25 46

Building 4 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	1 1	6 7	22/22	4 6	4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	1 9	22/22	0 88	0 71	0	5 0E 03	NTV	1 01
Chromium	mg/kg	2	48	22/22	28 5	23 9	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	0 65	14/22	0 15	0 097	0 13	NTV	0 73	0 89
Benzo(a)pyrene	mg/kg	0 002	0 48	13/22	0 078	0 041	0 13	NTV	7 3	0 74
Benzo(b)fluoranthene	mg/kg	0 003	0 7	13/22	0 16	0 11	0 13	NTV	0 73	0 63
Dibenz(a,h)anthracene	mg/kg	0 004	0 17	4/22	0 045	0 034	0 13	NTV	7 3	0 3

, Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-3-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{0 al})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{0 al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{0 al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{0 al} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	0.88	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA	
Chromium	28.5	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA	
Benzo(a)anthracene	0.15	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.4E 9	
Benzo(a)pyrene	0.078	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	7.4E 9	
Benzo(b)fluoranthene	0.16	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.5E 9	
Dibenz(a,h)anthracene	0.045	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	4.3E 9	
													Total	0.0E+0	1.5E 8

Attachment A-3-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{o al})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{o al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{o al}	SF _{o al}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	5.9E 4	NA
Chromium	28.5	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	4.8E 3	NA
Benzo(a)anthracene	0.15	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.2E 9
Benzo(a)pyrene	0.078	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	6.3E 9
Benzo(b)fluoranthene	0.16	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.3E 9
Dibenz(a h)anthracene	0.045	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	3.6E 9
										Total	5.4E 3	1.2E 8

Attachment A-3-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.71	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E-03	NTV	0.0E+0	NA
Chromium	23.9	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E-02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.097	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E-01	NA	6.2E-11
Benzo(a)pyrene	0.041	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.6E-10
Benzo(b)fluoranthene	0.11	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E-01	NA	7.0E-11
Dibenz(a,h)anthracene	0.034	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.2E-10
Total												0.0E+0	6.1E-10	

Attachment A-3-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
Beryllium	0.71	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.4E 4	NA
Chromium	23.9	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.2E 3	NA
Benzo(a)anthracene	0.097	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.2E 10
Benzo(a)pyrene	0.041	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	5.0E 10
Benzo(b)fluoranthene	0.11	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.3E 10
Dibenz(a h)anthracene	0.034	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	4.2E 10
Total										1.4E 3	1.2E 9	

Attachment A-3-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	27	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-3-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	4 3E 4	NA
Chromium	27	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	8 8E 3	NA
										Total	9 2E 3	0 0E+0

Attachment A-3-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	21	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-3-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	50	250	5	70	1 825	25 550	2.0E 03	NTV	1.6E 4	NA
Chromium	21	1E 6	50	250	5	70	1 825	25 550	3.0E 03	NTV	3.4E 3	NA
										Total	3.6E 3	0.0E+0

Attachment A-3-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	27	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-3-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	100	12	30	70	10 950	25 550	2.0E 03	NTV	2.1E 5	NA
Chromium	27	1E 6	100	12	30	70	10 950	25 550	3.0E 03	NTV	4.2E 4	NA
										Total	4.4E 4	0.0E+0

Attachment A-3-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	21	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-3-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	50	6	9	70	3.285	25 550	2.0E 03	NTV	3.8E 6	NA
Chromium	21	1E 6	50	6	9	70	3.285	25 550	3.0E 03	NTV	8.2E 5	NA
										Total	8.6E 5	0.0E+0

Attachment A-3-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm^2)

AB = Absorbed Fraction (unitless)

SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)

SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	0	NA
Chromium	27	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
															Total	0 0E+0	0 0E+0

Attachment A-3-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.88	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	5.6E 3	NA
Chromium	27	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1.2E 1	NA
													Total	1.2E 1	0.0E+0

Attachment A-3-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad_lt} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad_lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad_lt} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{ad_lt} \cdot ED_{ad_lt} / BW_{ad_lt}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad_lt}	EF	ED _{child}	ED _{ad_lt}	BW _{child}	BW _{ad_lt}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	21	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	0.0E+0	NA
															Total	0.0E+0	0.0E+0

Attachment A-3-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	0.65	1E 6	100	50	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	2 1E 3	NA	
Chromium	21	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	4 5E 2	NA	
														Total	4 7E 2	0 0E+0

Attachment A-3-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 4 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	6 1E 10	1 5E 8
Ingestion	0 0014	0 0054	1 2E 9	1 2E 8
Total	0 0014	0 0054	1 8E 9	2 7E 8
Future Industrial/Commercial Worker				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 0036	0 0092	0 0E+0	0 0E+0
Total	0 0036	0 0092	0 0E+0	0 0E+0
Current Trespasser/Site Visitor				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 000086	0 00044	0 0E+0	0 0E+0
Total	0 000086	0 00044	0 0E+0	0 0E+0
Hypothetical Future Resident				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 047	0 12	0 0E+0	0 0E+0
Total	0 047	0 12	0 0E+0	0 0E+0

Attachment A 4-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 5 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
4,4'DDE	mg/kg	0.0011	65	15/16	11.2	4.1	0.03	5.0E 04	3.4E 01	
4,4'DDT	mg/kg	0.012	1100	16/16	189	69	0.03	5.0E-04	3.4E 01	
Arsenic	mg/kg	3.2	8.5	16/16	4.9	4.4	0.03	NE	NE	13.22
Beryllium	mg/kg	0.35	0.82	16/16	0.63	0.57	0	NE	NE	1.01
Chromium	mg/kg	18	151	16/16	44.7	30.6	0	3.0E 03	NTV	25.46
Lead	mg/kg	8.6	1790	16/16	333	140	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0.002	25	15/16	4.3	1.6	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.002	19	15/16	3.3	1.2	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.003	16	15/16	2.8	1.1	0.13	NTV	7.3E 01	0.63
Benzo(k)fluoranthene	mg/kg	0.002	19	15/16	3.3	1.2	0.13	NTV	7.3E 02	0.46
Dibenz(a,h)anthracene	mg/kg	0.002	7.1	8/16	1.24	0.47	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	0.001	11	15/16	0.37	0.18	0.13	NTV	7.3E 01	0.41

Building 5 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg-day) ¹	Background
4,4'DDE	mg/kg	0.0006	65	22/32	5.5	2.1	0.03	5.0E 04	3.4E 01	
4,4'DDT	mg/kg	0.0009	1100	29/32	92.8	34.5	0.03	5.0E 04	3.4E 01	
Arsenic	mg/kg	1.9	8.5	32/32	4.65	4.28	0.03	NE	NE	13.22
Beryllium	mg/kg	0.35	0.88	32/32	0.64	0.6	0	NE	NE	1.01
Chromium	mg/kg	14	151	32/32	34.5	27.9	0	2.0E 02	NTV	25.46
Lead	mg/kg	5.7	1790	32/32	173	79.4	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0.002	25	21/32	2.2	0.87	0.13	NTV	7.3E 01	0.89
Benzo(a)pyrene	mg/kg	0.002	19	21/32	1.64	0.64	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.003	16	21/32	1.44	0.6	0.13	NTV	7.3E 01	0.63
Benzo(k)fluoranthene	mg/kg	0.002	19	22/32	1.67	0.67	0.13	NTV	7.3E 02	0.46
Dibenz(a,h)anthracene	mg/kg	0.002	7.1	12/32	0.62	0.25	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	0.001	11	22/32	1	0.42	0.13	NTV	7.3E 01	0.41

Present at background level

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-4 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_c \text{RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT})$$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	5.5	1E 6	0.9	0.03	3 300	60	1	70	84	25 550	5.0E 04	3.4E 01	1.0E 2	5.6E 9
4,4-DDT	92.8	1E 6	0.9	0.03	3 300	60	1	70	84	25 550	5.0E 04	3.4E 01	1.7E 1	9.4E 8
Chromium	34.5	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	2.2	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.1E 8
Benzo(a)pyrene	1.64	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.6E 7
Benzo(b)fluoranthene	1.44	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.4E 8
Benzo(k)fluoranthene	1.67	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 02	NA	1.6E 9
Dibenz(a,h)anthracene	0.62	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	5.9E 8
Indeno(1,2,3-cd)pyrene	1	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	9.5E 9
Total												1.8E 1	3.6E 7	

Attachment A-4-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	5.5	1E 6	330	60	1	70	84	25 550	5.0E 04	3.4E 01	3.7E 2	2.1E 8
4,4-DDT	92.8	1E 6	330	60	1	70	84	25 550	5.0E 04	3.4E 01	6.2E 1	3.5E 7
Chromium	34.5	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	5.8E 3	NA
Benzo(a)anthracene	2.2	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.8E 8
Benzo(a)pyrene	1.64	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.3E 7
Benzo(b)fluoranthene	1.44	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.2E 8
Benzo(k)fluoranthene	1.67	1E 6	330	60	1	70	84	25 550	NTV	7.3E 02	NA	1.3E 9
Dibenz(a,h)anthracene	0.62	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	5.0E 8
Indeno(1,2,3-cd)pyrene	1	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	8.1E 9
Total										6.7E 1	5.9E 7	

Attachment A-4-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _{nc}	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	2.1	1E 6	0.2	0.03	2 000	30	1	70	42	25 550	5.0E 04	3.4E 01	5.1E 4	1.4E 10
4,4-DDT	34.5	1E 6	0.2	0.03	2 000	30	1	70	42	25 550	5.0E 04	3.4E 01	8.4E 3	2.4E 9
Chromium	27.9	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.87	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	5.5E 10
Benzo(a)pyrene	0.64	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	4.1E 9
Benzo(b)fluoranthene	0.6	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	3.8E 10
Benzo(k)fluoranthene	0.67	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 02	NA	4.3E 11
Dibenz(a,h)anthracene	0.25	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.6E 9
Indeno(1,2,3-cd)pyrene	0.42	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.7E 10
Total												9.0E 3	9.4E 9	

Attachment A-4-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 R_{fD}_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	2.1	1E 6	100	30	1	70	42	25 550	5.0E 04	3.4E 01	4.3E 3	1.2E 9
4,4-DDT	34.5	1E 6	100	30	1	70	42	25 550	5.0E 04	3.4E 01	7.0E 2	2.0E 8
Chromium	27.9	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.4E 3	NA
Benzo(a)anthracene	0.87	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.1E 9
Benzo(a)pyrene	0.64	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	7.8E 9
Benzo(b)fluoranthene	0.6	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	7.3E 10
Benzo(k)fluoranthene	0.67	1E 6	100	30	1	70	42	25 550	NTV	7.3E 02	NA	8.2E 11
Dibenz(a,h)anthracene	0.25	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	3.1E 9
Indeno(1,2,3-cd)pyrene	0.42	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	5.1E 10
Total										7.6E 2	3.4E 8	

Attachment A-4-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_c \text{RfD}_{\text{al}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time for Non Carcinogens (days)

RfD_{al} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT})$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{al}	SF _{oral}	Hazard Index	Cancer Risk
DDE	11.2	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	3.4E 01	4.3E 3	2.6E 7
DDT	189	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	3.4E 01	7.3E 2	4.4E 6
Chromium	44.7	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	4.3	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	9.4E 7
Benzo(a)pyrene	3.3	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	7.2E 6
Benzo(b)fluoranthene	2.8	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	6.1E 7
Benzo(k)fluoranthene	3.3	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 02	NA	7.2E 8
Dibenz(a,h)anthracene	1.24	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.7E 6
Indeno(1,2,3-cd)pyrene	0.37	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	8.1E 8
												Total	7.8E 2	1.6E 5

Attachment A-4-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_{ref}D_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	11.2	1E 6	100	250	25	70	9 125	25 550	5.0E 04	3.4E 01	2.2E 2	1.3E 6
4,4-DDT	189	1E 6	100	250	25	70	9 125	25 550	5.0E 04	3.4E 01	3.7E 1	2.2E 5
Chromium	44.7	1E 6	100	250	25	70	9 125	25 550	3.0E 03	NTV	1.5E 2	NA
Benzo(a)anthracene	4.3	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.1E 6
Benzo(a)pyrene	3.3	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	8.4E 6
Benzo(b)fluoranthene	2.8	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	7.1E 7
Benzo(k)fluoranthene	3.3	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 02	NA	8.4E 8
Dibenz(a,h)anthracene	1.24	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	3.2E 6
Indeno(1,2,3-cd)pyrene	0.37	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	9.4E 8
Total										4.1E 1	3.7E 5	

Attachment A-4-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	4.1	1E 6	0.03	0.03	2,000	250	5	70	1,825	25,550	5.0E 04	3.4E 01	1.4E 4	1.8E 9
4,4-DDT	69	1E 6	0.03	0.03	2,000	250	5	70	1,825	25,550	5.0E 04	3.4E 01	2.4E 3	3.0E 8
Chromium	30.6	1E 6	0.03	0	2,000	250	5	70	1,825	25,550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.6	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E 01	NA	6.4E 9
Benzo(a)pyrene	1.2	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E+00	NA	4.8E 8
Benzo(b)fluoranthene	1.1	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E 01	NA	4.4E 9
Benzo(k)fluoranthene	1.2	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E 02	NA	4.8E 10
Dibenzo(a,h)anthracene	0.47	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E+00	NA	1.9E 8
Indeno(1,2,3-cd)pyrene	0.18	1E 6	0.03	0.13	2,000	250	5	70	1,825	25,550	NTV	7.3E 01	NA	7.2E 10
Total												2.6E 3	1.1E 7	

Attachment A 4-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	4.1	1E 6	50	250	5	70	1 825	25 550	5.0E 04	3.4E 01	4.0E 3	4.9E 8
4,4-DDT	69	1E 6	50	250	5	70	1 825	25 550	5.0E 04	3.4E 01	6.8E 2	8.2E 7
Chromium	30.6	1E 6	50	250	5	70	1 825	25 550	3.0E 03	NTV	5.0E 3	NA
Benzo(a)anthracene	1.6	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.1E 8
Benzo(a)pyrene	1.2	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	3.1E 7
Benzo(b)fluoranthene	1.1	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	2.8E 8
Benzo(k)fluoranthene	1.2	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 02	NA	3.1E 9
Dibenz(a,h)anthracene	0.47	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.2E 7
Indeno(1,2,3-cd)pyrene	0.18	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.6E 9
Total										7.7E 2	1.4E 6	

Attachment A-4 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{\text{oral}})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{\text{oral}}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDE	11.2	1E 6	0.3	0.03	3 300	12	30	70	10 950	25 550	5.0E 04	3.4E 01	3.1E 4	2.3E 8
4,4'-DDT	189	1E 6	0.3	0.03	3 300	12	30	70	10 950	25 550	5.0E 04	3.4E 01	5.3E 3	3.8E 7
Chromium	44.7	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	4.3	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	8.1E 8
Benzo(a)pyrene	3.3	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	6.2E 7
Benzo(b)fluoranthene	2.8	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	5.3E 8
Benzo(k)fluoranthene	3.3	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 02	NA	6.2E 9
Dibenz(a,h)anthracene	1.24	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.3E 7
Indeno(1,2,3-cd)pyrene	0.37	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	7.0E 9
Total												5.6E 3	1.4E 6	

Attachment A-4-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDE	11.2	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3.4E 01	1.1E 3	7.7E 8
4,4'-DDT	189	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3.4E 01	1.8E 2	1.3E 6
Chromium	44.7	1E 6	100	12	30	70	10 950	25 550	3.0E 03	NTV	7.0E 4	NA
Benzo(a)anthracene	4.3	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	6.3E 8
Benzo(a)pyrene	3.3	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	4.8E 7
Benzo(b)fluoranthene	2.8	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	4.1E 8
Benzo(k)fluoranthene	3.3	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 02	NA	4.8E 9
Dibenz(a,h)anthracene	1.24	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.8E 7
Indeno(1,2,3-cd)pyrene	0.37	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	5.4E 9
Total										2.0E 2	2.2E 6	

Attachment A-4 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _{nc}	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	4.1	1E 6	0.04	0.03	2 000	6	9	70	3 285	25 550	5.0E 04	3.4E 01	4.6E 6	1.0E 10
4,4-DDT	69	1E 6	0.04	0.03	2 000	6	9	70	3 285	25 550	5.0E 04	3.4E 01	7.8E 5	1.7E 9
Chromium	30.6	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.6	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	3.7E 10
Benzo(a)pyrene	1.2	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.8E 9
Benzo(b)fluoranthene	1.1	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.5E 10
Benzo(k)fluoranthene	1.2	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 02	NA	2.8E 11
Dibenz(a,h)anthracene	0.47	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.1E 9
Indeno(1,2,3-cd)pyrene	0.18	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	4.1E 11
												Total	8.2E 5	6.3E 9

Attachment A-4-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 R_{fD_{oral}} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	R _{fD_{oral}}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	4.1	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	9 6E 5	2 1E 9
4,4-DDT	69	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 6E 3	3 5E 8
Chromium	30.6	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA
Benzo(a)anthracene	1.6	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 8E 9
Benzo(a)pyrene	1.2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 8
Benzo(b)fluoranthene	1.1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 2E 9
Benzo(k)fluoranthene	1.2	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	1 3E 10
Dibenz(a,h)anthracene	0.47	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 2E 9
Indeno(1,2,3-cd)pyrene	0.18	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 0E 10
Total										1 8E 3	5 9E 8	

Attachment A 4 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI \approx (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{ref})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{ref} \cdot ((SA_{child} \cdot ED_{child}) / BW_{child}) + (SA_{adult} \cdot ED_{adult}) / BW_{adult})) / (AT_{nc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
DDE	11.2	1E 6	0.3	0.03	1 913	3 300	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	2.5E 2	8.9E 7
DDT	189	1E 6	0.3	0.03	1 913	3 300	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	4.2E 1	1.5E 5
Chromium	44.7	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	4.3	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.2E 6
Benzo(a)pyrene	3.3	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.4E 5
Benzo(b)fluoranthene	2.8	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	2.1E 6
Benzo(k)fluoranthene	3.3	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 02	NA	2.4E 7
Dibenz(a,h)anthracene	1.24	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	9.2E 6
Indeno(1,2,3-cd)pyrene	0.37	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	2.7E 7
Total																4.4E 1	5.5E 5

Attachment A 4 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{rel} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (25 550 days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{no}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
4,4-DDE	11.2	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	2.9E 1	6.0E 6
4,4-DDT	189	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	4.8E+0	1.0E 4
Chromium	44.7	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	1.9E 1	NA
Benzo(a)anthracene	4.3	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	4.9E 6
Benzo(a)pyrene	3.3	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	3.8E 5
Benzo(b)fluoranthene	2.8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.2E 6
Benzo(k)fluoranthene	3.3	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E-02	NA	3.8E 7
Dibenz(a,h)anthracene	1.24	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.4E 5
Indeno(1,2,3-cd)pyrene	0.37	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	4.2E 7
Total														5.3E+0	1.7E 4

Attachment A-4 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{c,ld} \cdot EF \cdot ED_{,ld}) / (BW_{,ld} \cdot AT_{nc} \cdot RfD_{,})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor, (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{ad} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{ld} = Exposure Duration for a Child (years)
 ED_{ad} = Exposure Duration for an Adult (years)
 BW_{ld} = Body Weight for a Child (kg)
 BW_{ad} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{rs} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rs} \cdot ((SA_{child} \cdot ED_{ld} / BW_{ld}) + (SA_{ad} \cdot ED_{ad} / BW_{ad}))) / (AT_{})$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rs} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{c,ld}	SA _{ad,II}	EF	ED _{ld}	ED _{adult}	BW _{ld}	BW _{ad,II}	AT _{nc}	AT	RfD _{rs}	SF _{rs}	Hazard Index	Cancer Risk
4,4-DDE	4.1	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E 04	3.4E 01	9.1E 4	1.5E 8
4,4-DDT	69	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E 04	3.4E 01	1.5E 2	2.6E 7
Chromium	30.6	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.6	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	5.5E 8
Benzo(a)pyrene	1.2	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	4.1E 7
Benzo(b)fluoranthene	1.1	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	3.8E 8
Benzo(k)fluoranthene	1.2	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 02	NA	4.1E 9
Dibenz(a,h)anthracene	0.47	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.6E 7
Indeno(1,2,3-cd)pyrene	0.18	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	6.2E 9
Total															1.6E 2	9.5E 7	

Attachment A-4-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{rel} \cdot ((IR_{child} \cdot ED_{child} \cdot BW_{child}) + (IR_{adult} \cdot ED_{adult} \cdot BW_{adult}))) / (AT_{carc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{carc} = Averaging Time for Carcinogens (25 550 days)
SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
DDE	4.1	1E-6	100	50	350	6	3	15	70	2190	25550	5.0E-04	3.4E-01	5.2E-2	8.0E-7
DDT	69	1E-6	100	50	350	6	3	15	70	2190	25550	5.0E-04	3.4E-01	8.8E-1	1.4E-5
Chromium	30.6	1E-6	100	50	350	6	3	15	70	2190	25550	3.0E-03	NTV	6.5E-2	NA
Benzo(a)anthracene	1.6	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	6.7E-7
Benzo(a)pyrene	1.2	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	5.1E-6
Benzo(b)fluoranthene	1.1	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	4.6E-7
Benzo(k)fluoranthene	1.2	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-02	NA	5.1E-8
Dibenz(a,h)anthracene	0.47	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	2.0E-6
Indeno(1,2,3-cd)pyrene	0.18	1E-6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E-01	NA	7.6E-8
Total														1.0E+0	2.3E-5

Attachment A-4-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 5 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0090	0 18	9 4E 9	3 6E 7
Ingestion	0 076	0 67	3 4E 8	5 9E 7
Total	<u>0 085</u>	<u>0 85</u>	<u>4 4E 8</u>	<u>9 5E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 0026	0 078	1 1E 7	1 6E 5
Ingestion	0 077	0 41	1 4E 6	3 7E 5
Total	<u>0 079</u>	<u>0 48</u>	<u>1 5E 6</u>	<u>5 4E 5</u>
Current Trespasser/Site Visitor				
Dermal	0 000082	0 0056	6 3E 9	1 4E 6
Ingestion	0 0018	0 020	5 9E 8	2 2E 6
Total	<u>0 0019</u>	<u>0 025</u>	<u>6 6E 8</u>	<u>3 6E 6</u>
Hypothetical Future Resident				
Dermal	0 016	0 44	9 5E 7	5 5E 5
Ingestion	1 0	5 3	2 3E 5	1 7E 4
Total	<u>1 0</u>	<u>5 8</u>	<u>2 4E 5</u>	<u>2 2E 4</u>

Attachment A 5 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 6 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
DDT	mg/kg	0 005	4	13/14	0 36	0 18	0 03	5 00E 04	3 4E 01	
Arsenic	mg/kg	3 6	5 7	14/14	4 6	4 4	0 03	NE	NE	13 22
Beryllium	mg/kg	0 74	1 6	14/14	1	0 89	0	2 00E 03	NTV	1 01
Mercury	mg/kg	0 015	1 5	13/14	0 62	0 38	0	3 00E 04	NTV	0 15

Building 6 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day)	Background
DDT	mg/kg	0 0006	21	23/28	2 21	0 93	0 03	5 00E-04	3 4E 01	
Arsenic	mg/kg	3 1	5 7	28/28	4 4	4 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 66	1 6	28/28	1 02	0 93	0	5 00E 03	NTV	1 01
Chromium	mg/kg	16	31	28/28	24 5	23 3	0	2 0E 02	NTV	25 46
Mercury	mg/kg	0 01	1 5	22/28	0 36	0 23	0	3 00E 03	NTV	0 15

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-5-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
DDT	2.21	1E 6	0.9	0.03	3 300	60	1	70	84	25 550	5.0E 04	3.4E 01	4.0E 3	2.2E 9	
Beryllium	1.02	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA	
Chromium	24.5	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA	
Mercury	0.36	1E 6	0.9	0	3 300	60	1	70	84	25 550	3.0E 03	NTV	0.0E+0	NA	
													Total	4.0E 3	2.2E 9

Attachment A-5-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_{fD_{oral}} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	2.21	1E 6	330	60	1	70	84	25 550	5.0E 04	3.4E 01	1.5E 2	8.3E 9
Beryllium	1.02	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	6.9E 4	NA
Chromium	24.5	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	4.1E 3	NA
Mercury	0.36	1E 6	330	60	1	70	84	25 550	3.0E 03	NTV	4.0E 4	NA
										Total	2.0E 2	8.3E 9

Attachment A-5-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.93	1E 6	0.2	0.03	2 000	30	1	70	42	25 550	5.0E 04	3.4E 01	2.3E 4	6.4E 11
Beryllium	0.93	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	23.3	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Mercury	0.23	1E 6	0.2	0	2 000	30	1	70	42	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	2.3E 4	6.4E 11

Attachment A-5-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.93	1E 6	100	30	1	70	42	25 550	5.0E 04	3.4E 01	1.9E 3	5.3E 10
Beryllium	0.93	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.9E 4	NA
Chromium	23.3	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.2E 3	NA
Mercury	0.23	1E 6	100	30	1	70	42	25 550	3.0E 03	NTV	7.8E 5	NA
										Total	3.4E 3	5.3E 10

Attachment A-5-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.36	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	3.4E 01	1.4E 4	8.5E 9
Beryllium	1	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	2.0E 03	NTV	0.0E+0	NA
Mercury	0.62	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 04	NTV	0.0E+0	NA
												Total	1.4E 4	8.5E 9

Attachment A-5-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.36	1E 6	100	250	25	70	9.125	25.550	5.0E 04	3.4E 01	7.0E 4	4.3E 8
Beryllium	1	1E 6	100	250	25	70	9.125	25.550	2.0E 03	NTV	4.9E 4	NA
Mercury	0.62	1E 6	100	250	25	70	9.125	25.550	3.0E 04	NTV	2.0E 3	NA
										Total	3.2E 3	4.3E 8

Attachment A-5-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.18	1E 6	0.03	0.03	2 000	250	5	70	1 825	25 550	5.0E 04	3.4E 01	6.3E 6	7.7E 11
Beryllium	0.89	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	2.0E 03	NTV	0.0E+0	NA
Mercury	0.38	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 04	NTV	0.0E+0	NA
												Total	6.3E 6	7.7E 11

Attachment A-5-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.18	1E 6	50	250	5	70	1 825	25 550	5.0E 04	3.4E 01	1.8E 4	2.1E 9
Beryllium	0.89	1E 6	50	250	5	70	1 825	25 550	2.0E 03	NTV	2.2E 4	NA
Mercury	0.38	1E 6	50	250	5	70	1 825	25 550	3.0E 04	NTV	6.2E 4	NA
										Total	1.0E 3	2.1E 9

Attachment A-5-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.36	1E 6	0.3	0.03	3 300	12	30	70	10 950	25 550	5.0E 04	3.4E 01	1.0E 5	7.3E 10
Beryllium	1	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	2.0E 03	NTV	0.0E+0	NA
Mercury	0.62	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E 04	NTV	0.0E+0	NA
													Total	1.0E 5
														7.3E 10

Attachment A-5-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
DDT	0.36	1E 6	100	12	30	70	10 950	25 550	5.0E 04	3.4E 01	3.4E 5	2.5E 9
Beryllium	1	1E 6	100	12	30	70	10 950	25 550	2.0E 03	NTV	2.3E 5	NA
Mercury	0.62	1E 6	100	12	30	70	10 950	25 550	3.0E 04	NTV	9.7E 5	NA
											Total	1.5E 4
												2.5E 9

Attachment A-5-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
DDT	0.18	1E 6	0.04	0.03	2 000	6	9	70	3 285	25 550	5.0E 04	3.4E 01	2.0E 7	4.4E 12	
Beryllium	0.89	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	2.0E 03	NTV	0.0E+0	NA	
Mercury	0.38	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 04	NTV	0.0E+0	NA	
													Total	2.0E 7	4.4E 12

Attachment A-5-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDT	0 18	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	4 2E 6	9 2E 11
Beryllium	0 89	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	5 2E 6	NA
Mercury	0 38	1E 6	50	6	9	70	3 285	25 550	3 0E 04	NTV	1 5E 5	NA
										Total	2 4E 5	9 2E 11

Attachment A-5-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
DDT	0.36	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	5.0E 04	3.4E 01	0.00079245	2.9E 8	
Beryllium	1	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E 03	NTV	0	NA	
Mercury	0.62	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E 04	NTV	0	NA	
																Total	7.9E 4	2.9E 8

Attachment A-5-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad lt} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{ad lt} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{ad lt} \cdot ED_{ad lt} / BW_{ad lt}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{ad lt}	EF	ED _{child}	ED _{ad lt}	BW _{child}	BW _{ad lt}	AT	AT	RfD	SF _{oral}	Hazard Index	Cancer Risk	
DDT	0.36	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E 04	3 4E 01	9.2E 3	1.9E 7	
Beryllium	1	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	6.4E 3	NA	
Mercury	0.62	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	NTV	2.6E 2	NA	
														Total	4.2E 2	1.9E 7

Attachment A-5 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)

SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD	SF _{oral}	Hazard Index	Cancer Risk
DDT	0.18	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	4.0E-5	6.7E-10
Beryllium	0.89	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-03	NTV	0.0E+0	NA
Mercury	0.38	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-04	NTV	0.0E+0	NA
															Total	4.0E-5	6.7E-10

Attachment A-5-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT _c	RfD	SF _{oral}	Hazard Index	Cancer Risk	
DDT	0.18	1E 6	100	50	350	6	3	15	70	2 190	25 550	5.0E 04	3.4E 01	2.3E 3	3.5E 8	
Beryllium	0.89	1E 6	100	50	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	2.8E 3	NA	
Mercury	0.38	1E 6	100	50	350	6	3	15	70	2 190	25 550	3.0E 04	NTV	8.1E 3	NA	
														Total	1.3E 2	3.5E 8

Attachment A-5-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 00023	0 0040	6 4E 11	2 2E 9
Ingestion	0 0034	0 020	5 3E 10	8 3E 9
Total	<u>0 0036</u>	<u>0 024</u>	<u>5 9E 10</u>	<u>1 1E 8</u>
Future Industrial/Commercial Worker				
Dermal	0 0000063	0 00014	7 7E 11	8 5E 9
Ingestion	0 0010	0 0032	2 1E 9	4 3E 8
Total	<u>0 0010</u>	<u>0 0034</u>	<u>2 2E 9</u>	<u>5 1E 8</u>
Current Trespasser/Site Visitor				
Dermal	0 00000020	0 000010	4 4E 12	7 3E 10
Ingestion	0 000024	0 00015	9 2E 11	2 5E 9
Total	<u>0 000025</u>	<u>0 00016</u>	<u>9 7E 11</u>	<u>3 2E 9</u>
Hypothetical Future Resident				
Dermal	0 000040	0 00079	6 7E 10	2 9E 8
Ingestion	0 013	0 042	3 5E 8	1 9E 7
Total	<u>0 013</u>	<u>0 043</u>	<u>3 6E 8</u>	<u>2 2E 7</u>

Attachment A 6 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 7 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
PCB 1254	mg/kg	0.016	0.34	8/16	0.12	0.089	0.14	2.0E-05	2/1 ^a	
Arsenic	mg/kg	3.2	7.3	16/16	6.1	5.6	0.03	NE	NE	13.22
Beryllium	mg/kg	0.33	0.88	16/16	0.61	0.55	0	NE	NE	1.01
Chromium	mg/kg	16	42	16/16	31.8	28.8	0	3.0E-03	NTV	25.46
Lead	mg/kg	10	900	16/16	136	82	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0.006	3.8	15/16	1.54	0.84	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.008	2.8	15/16	1.16	0.66	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.01	4	15/16	1.54	0.87	0.13	NTV	7.3E-01	0.63
Dibenz(a h)anthracene	mg/kg	0.009	0.25	14/16	0.14	0.07	0.13	NTV	7.3E+00	0.3
Indeno(1 2 3-cd)pyrene	mg/kg	0.004	1.7	15/16	0.75	0.44	0.13	NTV	7.3E-01	0.41

Building 7 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day)	Background
PCB 1254	mg/kg	0.016	0.34	8/44	0.11	0.096	0.14	5.0E-05	2/1 ^a	
Arsenic	mg/kg	1.1	7.3	44/44	4.9	4.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.33	1.3	44/44	0.71	0.66	0	5.0E-03	NTV	1.01
Chromium	mg/kg	16	55	44/44	32	30	0	2.0E-02	NTV	25.46
Lead	mg/kg	5.3	900	44/44	80	47	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0.002	3.8	30/44	0.56	0.36	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.002	2.8	34/44	0.35	0.21	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.004	4	32/44	0.57	0.36	0.13	NTV	7.3E-01	0.63
Dibenz(a h)anthracene	mg/kg	0.004	0.25	21/44	0.053	0.042	0.13	NTV	7.3E+00	0.3
Indeno(1 2 3 cd)pyrene	mg/kg	0.001	1.7	29/44	0.26	0.19	0.13	NTV	7.3E-01	0.41

Present at background level

Lead has no RfD or SF and is evaluated separately

IRIS recommends using a slope factor of 2.0 for RME and 1.0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-6-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{or})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{or} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{or}	Hazard Index	Cancer Risk
PCB 1254	0.11	1E 6	0.9	0.14	3 300	60	1	70	84	25 550	5.0E 05	2.0E+00	9.3E 3	3.1E 9
Beryllium	0.71	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	32	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.56	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	5.3E 9
Benzo(a)pyrene	0.35	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	3.3E 8
Benzo(b)fluoranthene	0.57	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	5.4E 9
Dibenz(a,h)anthracene	0.053	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	5.0E 9
Indeno(1,2,3 cd)pyrene	0.26	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.5E 9
Total												9.3E 3	5.4E 8	

Attachment A-6-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.11	1E 6	330	60	1	70	84	25 550	5.0E 05	2.0E+00	7.4E 3	2.4E 9
Beryllium	0.71	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	4.8E 4	NA
Chromium	32	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	5.4E 3	NA
Benzo(a)anthracene	0.56	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	4.5E 9
Benzo(a)pyrene	0.35	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	2.8E 8
Benzo(b)fluoranthene	0.57	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	4.6E 9
Dibenz(a h)anthracene	0.053	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	4.3E 9
Indeno(1 2 3 cd)pyrene	0.26	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.1E 9
Total										1.3E 2	4.6E 8	

Attachment A-6-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.096	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	1 1E 3	9 0E 11
Beryllium	0.66	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0.36	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Benzo(a)pyrene	0.21	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 3E 9
Benzo(b)fluoranthene	0.36	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Dibenz(a,h)anthracene	0.042	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 7E 10
Indeno(1 2 3 cd)pyrene	0.19	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 2E 10
												Total	1 1E 3	2 3E 9

Attachment A-6-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.096	1E 6	100	30	1	70	42	25 550	5.0E 05	1.0E+00	2.0E 3	1.6E 10
Beryllium	0.66	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.3E 4	NA
Chromium	30	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.5E 3	NA
Benzo(a)anthracene	0.36	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	4.4E 10
Benzo(a)pyrene	0.21	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	2.6E 9
Benzo(b)fluoranthene	0.36	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	4.4E 10
Dibenz(a,h)anthracene	0.042	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	5.1E 10
Indeno(1,2,3-cd)pyrene	0.19	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.3E 10
Total										3.6E 3	4.4E 9	

Attachment A-6-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/cm²)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.12	1E 6	0.20	0.14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	5.4E 3	7.7E 8
Chromium	31.8	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.54	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	3.4E 7
Benzo(a)pyrene	1.16	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.5E 6
Benzo(b)fluoranthene	1.54	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	3.4E 7
Dibenz(a h)anthracene	0.14	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	3.1E 7
Indeno(1 2 3 cd)pyrene	0.75	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.6E 7
Total													5.4E 3	3.8E 6

Attachment A-6-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	5 9E 3	8 4E 8
Chromium	31 8	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
Benzo(a)anthracene	1 54	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 9E 7
Benzo(a)pyrene	1 16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 0E 6
Benzo(b)fluoranthene	1 54	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 9E 7
Dibenz(a h)anthracene	0 14	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 6E 7
Indeno(1 2 3 cd)pyrene	0 75	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 9E 7
Total										1 6E 2	4 4E 6	

Attachment A-6-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E 6	0.03	0.14	2 000	250	5	70	1 825	25 550	2.0E 05	1.0E+00	3.7E 4	5.2E 10
Chromium	28.8	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	0.84	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.3E 9
Benzo(a)pyrene	0.66	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.6E 8
Benzo(b)fluoranthene	0.87	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.5E 9
Dibenz(a h)anthracene	0.07	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.8E 9
Indeno(1 2 3 cd)pyrene	0.44	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	1.8E 9
Total												3.7E 4	3.8E 8	

Attachment A-6-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E 6	50	250	5	70	1.825	25 550	2.0E 05	1.0E+00	2.2E 3	3.1E 9
Chromium	28.8	1E 6	50	250	5	70	1.825	25 550	3.0E 03	NTV	4.7E 3	NA
Benzo(a)anthracene	0.84	1E 6	50	250	5	70	1.825	25 550	NTV	7.3E 01	NA	2.1E 8
Benzo(a)pyrene	0.66	1E 6	50	250	5	70	1.825	25 550	NTV	7.3E+00	NA	1.7E 7
Benzo(b)fluoranthene	0.87	1E 6	50	250	5	70	1.825	25 550	NTV	7.3E 01	NA	2.2E 8
Dibenz(a,h)anthracene	0.07	1E 6	50	250	5	70	1.825	25 550	NTV	7.3E+00	NA	1.8E 8
Indeno(1,2,3 cd)pyrene	0.44	1E 6	50	250	5	70	1.825	25 550	NTV	7.3E 01	NA	1.1E 8
Total										6.9E 3	2.4E 7	

Attachment A-6-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{nc} \text{ RfD}_{oral})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{oral}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0 12	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	3 9E 4	6 7E 9
Chromium	31 8	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1 54	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 9E 8
Benzo(a)pyrene	1 16	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 2E 7
Benzo(b)fluoranthene	1 54	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 9E 8
Dibenz(a h)anthracene	0 14	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 8
Indeno(1 2 3 cd)pyrene	0 75	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 4E 8
												Total	3 9E 4	3 2E 7

Attachment A-6-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
PCB 1254	0.12	1E 6	100	12	30	70	10 950	25 550	2.0E 05	2.0E+00	2.8E 4	4.8E 9
Chromium	31.8	1E 6	100	12	30	70	10 950	25 550	3.0E 03	NTV	5.0E 4	NA
Benzo(a)anthracene	1.54	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	2.3E 8
Benzo(a)pyrene	1.16	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.7E 7
Benzo(b)fluoranthene	1.54	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	2.3E 8
Dibenz(a h)anthracene	0.14	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.1E 8
Indeno(1 2 3 cd)pyrene	0.75	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.1E 8
Total										7.8E 4	2.5E 7	

Attachment A-6-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E 6	0.04	0.14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1.2E 5	3 0E 11
Chromium	28.8	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	0.84	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.9E 10
Benzo(a)pyrene	0.66	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.5E 9
Benzo(b)fluoranthene	0.87	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.0E 10
Dibenz(a h)anthracene	0.07	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.6E 10
Indeno(1 2 3 cd)pyrene	0.44	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.0E 10
Total													1.2E 5	2.2E 9

Attachment A-6-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_c \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	5.2E 5	1.3E 10
Chromium	28.8	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1.1E 4	NA
Benzo(a)anthracene	0.84	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	9.3E 10
Benzo(a)pyrene	0.66	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	7.3E 9
Benzo(b)fluoranthene	0.87	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	9.6E 10
Dibenz(a h)anthracene	0.07	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	7.7E 10
Indeno(1 2 3 cd)pyrene	0.44	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	4.8E 10
Total										1.6E 4	1.1E 8	

Attachment A 6 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{child})$
 (hazard estimate assumes child only exposure)

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{child} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{child} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT \cdot SF_{adult})$
 (cancer risk assumes child + adult exposure)

Where
 CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{adult} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{child}	AT _{adult}	RfD _{child}	SF _{adult}	Hazard Index	Cancer Risk
PCB 1254	0.12	1E 6	0.3	0.14	1 913	3 300	350	6	24	15	70	2 190	25 550	2.0E-05	2.0E+00	0.03081764	2.6E-7
Chromium	31.8	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E-03	NTV	0	NA
Benzo(a)anthracene	1.54	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-6
Benzo(a)pyrene	1.16	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.6E-6
Benzo(b)fluoranthene	1.54	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-6
Dibenz(a,h)anthracene	0.14	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.0E-6
Indeno(1,2,3-cd)pyrene	0.75	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	5.5E-7
Total																3.1E-2	1.3E-5

Attachment A 6 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non-Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.12	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E-05	2.0E+00	7.7E 2	3.8E 7
Chromium	31.8	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E-03	NTV	1.4E 1	NA
Benzo(a)anthracene	1.54	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.8E 6
Benzo(a)pyrene	1.16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.3E 5
Benzo(b)fluoranthene	1.54	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	1.8E 6
Dibenz(a,h)anthracene	0.14	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.6E 6
Indeno(1,2,3-cd)pyrene	0.75	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	8.6E 7
Total														2.1E 1	2.0E 5

Attachment A-6 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_{nc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E-6	0.04	0.14	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	2.3E-3	4.5E-9
Chromium	28.8	1E-6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)anthracene	0.84	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	2.9E-8
Benzo(a)pyrene	0.66	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	2.3E-7
Benzo(b)fluoranthene	0.87	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	3.0E-8
Dibenz(a,h)anthracene	0.07	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	2.4E-8
Indeno(1,2,3 cd)pyrene	0.44	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.5E-8
Total																2.3E-3	3.3E-7

Attachment A 6 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.089	1E-6	100	50	350	6	3	15	70	2190	25 550	2.0E-05	1.0E+00	2.8E-2	5.1E-8
Chromium	28.8	1E-6	100	50	350	6	3	15	70	2190	25 550	3.0E-03	NTV	6.1E-2	NA
Benzo(a)anthracene	0.84	1E-6	100	50	350	6	3	15	70	2190	25 550	NTV	7.3E-01	NA	3.5E-7
Benzo(a)pyrene	0.66	1E-6	100	50	350	6	3	15	70	2190	25 550	NTV	7.3E+00	NA	2.8E-6
Benzo(b)fluoranthene	0.87	1E-6	100	50	350	6	3	15	70	2190	25 550	NTV	7.3E-01	NA	3.7E-7
Dibenz(a,h)anthracene	0.07	1E-6	100	50	350	6	3	15	70	2190	25 550	NTV	7.3E+00	NA	3.0E-7
Indeno(1,2,3-cd)pyrene	0.44	1E-6	100	50	350	6	3	15	70	2190	25 550	NTV	7.3E-01	NA	1.9E-7
Total														9.0E-2	4.0E-6

Attachment A-6-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 7 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0011	0 0093	2 3E 9	5 4E 8
Ingestion	0 0036	0 013	4 4E 9	4 6E 8
Total	<u>0 0047</u>	<u>0 023</u>	<u>6 6E 9</u>	<u>1 0E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 00037	0 0054	3 8E 8	3 8E 6
Ingestion	0 0069	0 016	2 4E 7	4 4E 6
Total	<u>0 0072</u>	<u>0 022</u>	<u>2 8E 7</u>	<u>8 1E 6</u>
Current Trespasser/Site Visitor				
Dermal	0 000012	0 00039	2 2E 9	3 2E 7
Ingestion	0 00016	0 00078	1 1E 8	2 5E 7
Total	<u>0 00018</u>	<u>0 0012</u>	<u>1 3E 8</u>	<u>5 8E 7</u>
Hypothetical Future Resident				
Dermal	0 0023	0 031	3 3E 7	1 3E 5
Ingestion	0 090	0 21	4 0E 6	2 0E 5
Total	<u>0 092</u>	<u>0 24</u>	<u>4 4E 6</u>	<u>3 2E 5</u>

Attachment A 7 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Building 8 Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg day)	SF _{ref} (mg/kg day) ¹	Background
Arsenic	mg/kg	2 5	9 8	20/20	7 6	7	0 3	NE	NE	13 22
Beryllium	mg/kg	0 29	0 94	20/20	0 66	0 59	0	NE	NE	1 01
Benzo(a)pyrene	mg/kg	0 003	0 21	18/20	0 075	0 049	0 13	NTV	7 3E+00	0 74

Building 8 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg day)	SF _{ref} (mg/kg day) ¹	Background
Arsenic	mg/kg	2 5	9 8	60/60	7 3	6 9	0 03	NE	NE	13 22
Beryllium	mg/kg	0 22	0 94	60/60	0 63	0 6	0	NE	NE	1 01
Chromium	mg/kg	12	30	60/60	20	19	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	2	33/60	0 21	0 16	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 003	0 99	34/60	0 1	0 07	0 13	NTV	7 3E+00	0 74
Dibenz(a h)anthracene	mg/kg	0 001	0 14	20/60	0 036	0 03	0 13	NTV	7 3E+00	0 3

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-7-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 21	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 9
Benzo(a)pyrene	0 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	9 5E 9
Dibenz(a h)anthracene	0 036	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 4E 9
												Total	0 0E+0	1 5E 8

Attachment A-7-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	20	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	3 4E 3	NA
Benzo(a)anthracene	0 21	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 7E 9
Benzo(a)pyrene	0 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 1E 9
Dibenz(a h)anthracene	0 036	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 9E 9
										Total	3 4E 3	1 3E 8

Attachment A-7-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	19	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 16	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	1 0E 10
Benzo(a)pyrene	0 07	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	4 5E 10
Dibenz(a h)anthracene	0 03	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 9E 10
												Total	0 0E+0	7 4E 10

Attachment A-7-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	19	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	9 7E 4	NA
Benzo(a)anthracene	0 16	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	2 0E 10
Benzo(a)pyrene	0 07	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	8 6E 10
Dibenz(a,h)anthracene	0 03	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 7E 10
										Total	9 7E 4	1 4E 9

Attachment A-7-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.075	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.6E 7
												Total	0.0E+0	1.6E 7

Attachment A-7-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.075	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.9E-7
										Total	0.0E+0	1.9E-7

Attachment A-7-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.049	1E 6	0.03	0.13	2.000	250	5	70	1.825	25.550	NTV	7.3E+00	NA	2.0E-9
												Total	0.0E+0	2.0E-9

Attachment A-7-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.049	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.3E 8	
											Total	0.0E+0	1.3E 8

Attachment A-7-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.075	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.4E 8
												Total	0.0E+0	1.4E 8

Attachment A-7-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.075	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.1E 8
										Total	0.0E+0	1.1E 8

Attachment A-7-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.049	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	1.1E 10
												Total	0.0E+0	1.1E 10

Attachment A-7-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.049	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	5.4E 10
										Total	0.0E+0	5.4E 10

Attachment A-7-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.075	1E 6	0.3	0.13	1913	3300	350	6	24	15	70	2190	25550	NTV	7.3E+00	NA	5.5E-7
															Total	0.0E+0	5.5E-7

Attachment A-7-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.075	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.6E-7	
														Total	0.0E+0	8.6E-7

Attachment A-7-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.049	1E-6	0.04	0.13	1440	2000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	1.7E-8
Total															0.0E+0		1.7E-8

Attachment A-7-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT_c	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.049	1E 6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	2.1E-7
													Total	0.0E+0	2.1E-7

Attachment A-7-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Building 8 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	7 4E 10	1 5E 8
Ingestion	0 00097	0 0034	1 4E 9	1 3E 8
Total	<u>0 0010</u>	<u>0 0034</u>	<u>2 2E 9</u>	<u>2 8E 8</u>
Future Industrial/Commercial Worker				
Dermal	0	0	2 0E 9	1 6E 7
Ingestion	0	0	1 3E 8	1 9E 7
Total	<u>0</u>	<u>0</u>	<u>1 4E 8</u>	<u>3 6E 7</u>
Current Trespasser/Site Visitor				
Dermal	0	0	1 1E 10	1 4E 8
Ingestion	0	0	5 4E 10	1 1E 8
Total	<u>0</u>	<u>0</u>	<u>6 5E 10</u>	<u>2 5E 8</u>
Hypothetical Future Resident				
Dermal	0	0	1 7E 8	5 5E 7
Ingestion	0	0	2 1E 7	8 6E 7
Total	<u>0</u>	<u>0</u>	<u>2 2E 7</u>	<u>1 4E 6</u>

Attachment A 8 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Northeast Parking Area Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg-day)	SF _{ref} (mg/kg day) ¹	Background
Arsenic	mg/kg	2 6	9 8	8/8	8 7	7 1	0 03	NE	NE	13 22
Beryllium	mg/kg	0 23	0 94	8/8	0 85	0 7	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 013	2 2	8/8	0 5	0 23	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 016	1 8	8/8	0 42	0 19	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 023	2 5	8/8	0 55	0 25	0 13	NTV	7 3E 01	0 63
Dibenz(a,h)anthracene	mg/kg	0 012	0 19	4/8	0 086	0 048	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 008	1 1	8/8	0 26	0 12	0 13	NTV	7 3E 01	0 41

Northeast Parking Area Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg day)	SF _{ref} (mg/kg day) ¹	Background
Arsenic	mg/kg	2 1	9 8	24/24	6 5	5 7	0 03	NE	NE	13 22
Beryllium	mg/kg	0 18	0 94	24/24	0 7	0 65	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 008	2 2	14/24	0 34	0 2	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 008	1 8	14/24	0 25	0 12	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 016	2 5	14/24	0 39	0 21	0 13	NTV	7 3E 01	0 63
Dibenz(a,h)anthracene	mg/kg	0 004	0 19	7/24	0 046	0 035	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3-cd)pyrene	mg/kg	0 004	1 1	14/24	0 21	0 13	0 13	NTV	7 3E 01	0 41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-8-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.34	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	3.2E 9
Benzo(a)pyrene	0.25	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	2.4E 8
Benzo(b)fluoranthene	0.39	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	3.7E 9
Dibenz(a h)anthracene	0.046	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	4.3E 9
Indeno(1 2 3 cd)pyrene	0.21	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.0E 9
												Total	0.0E+0	3.7E 8

Attachment A-8-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{o,al})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{o,al} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{o,al}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o,al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.34	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.7E 9
Benzo(a)pyrene	0.25	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	2.0E 8
Benzo(b)fluoranthene	0.39	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	3.2E 9
Dibenz(a,h)anthracene	0.046	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	3.7E 9
Indeno(1,2,3-cd)pyrene	0.21	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.7E 9
										Total	0.0E+0	3.2E 8

Attachment A-8-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.2	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	1.3E 10
Benzo(a)pyrene	0.12	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	7.6E 10
Benzo(b)fluoranthene	0.21	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	1.3E 10
Dibenz(a h)anthracene	0.035	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.2E 10
Indeno(1 2 3 cd)pyrene	0.13	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	8.3E 11
												Total	0.0E+0	1.3E 9

Attachment A-8-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.2	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.4E 10
Benzo(a)pyrene	0.12	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.5E 9
Benzo(b)fluoranthene	0.21	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.6E 10
Dibenz(a h)anthracene	0.035	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	4.3E 10
Indeno(1 2 3 cd)pyrene	0.13	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.6E 10
										Total	0.0E+0	2.6E 9

Attachment A-8-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _{nc}	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.5	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.1E 7
Benzo(a)pyrene	0.42	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	9.2E 7
Benzo(b)fluoranthene	0.55	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.2E 7
Dibenz(a h)anthracene	0.086	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.9E 7
Indeno(1 2 3 cd)pyrene	0.26	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	5.7E 8
Total												0.0E+0		1.4E 6

Attachment A-8-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.5	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.3E 7
Benzo(a)pyrene	0.42	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.1E 6
Benzo(b)fluoranthene	0.55	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	1.4E 7
Dibenz(a h)anthracene	0.086	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.2E 7
Indeno(1 2 3 cd)pyrene	0.26	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	6.6E 8
Total										0.0E+0		1.6E 6

Attachment A-8-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	9.2E 10
Benzo(a)pyrene	0.19	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	7.6E 9
Benzo(b)fluoranthene	0.25	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	9.9E 10
Dibenz(a h)anthracene	0.048	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.9E 9
Indeno(1 2 3 cd)pyrene	0.12	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.8E 10
												Total	0.0E+0	1.2E 8

Attachment A-8-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	5.9E 9
Benzo(a)pyrene	0.19	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.8E 8
Benzo(b)fluoranthene	0.25	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	6.4E 9
Dibenz(a h)anthracene	0.048	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.2E 8
Indeno(1 2 3 cd)pyrene	0.12	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.1E 9
										Total	0.0E+0	7.6E 8

Attachment A-8-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.5	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	9.5E 9
Benzo(a)pyrene	0.42	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	7.9E 8
Benzo(b)fluoranthene	0.55	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.0E 8
Dibenz(a h)anthracene	0.086	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.6E 8
Indeno(1 2 3 cd)pyrene	0.26	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	4.9E 9
												Total	0.0E+0	1.2E 7

Attachment A-8-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.5	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	7.3E 9
Benzo(a)pyrene	0.42	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	6.2E 8
Benzo(b)fluoranthene	0.55	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	8.1E 9
Dibenz(a h)anthracene	0.086	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.3E 8
Indeno(1 2 3 cd)pyrene	0.26	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	3.8E 9
										Total	0.0E+0	9.4E 8

Attachment A-8-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	5.3E 11
Benzo(a)pyrene	0.19	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	4.4E 10
Benzo(b)fluoranthene	0.25	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	5.7E 11
Dibenz(a h)anthracene	0.048	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.1E 10
Indeno(1 2 3 cd)pyrene	0.12	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.8E 11
Total												0.0E+0		6.8E 10

Attachment A-8-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2.5E 10
Benzo(a)pyrene	0.19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2.1E 9
Benzo(b)fluoranthene	0.25	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2.8E 10
Dibenz(a,h)anthracene	0.048	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5.3E 10
Indeno(1,2,3-cd)pyrene	0.12	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1.3E 10
										Total	0.0E+0	3.3E 9

Attachment A-8 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD	SF	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.5	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.7E 7
Benzo(a)pyrene	0.42	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	3.1E 6
Benzo(b)fluoranthene	0.55	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	4.1E 7
Dibenz(a h)anthracene	0.086	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	6.4E 7
Indeno(1 2 3 cd)pyrene	0.26	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.9E 7
															Total	0.0E+0	4.7E 6

Attachment A-8-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)anthracene	0.5	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	5.7E 7
Benzo(a)pyrene	0.42	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	4.8E 6
Benzo(b)fluoranthene	0.55	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	6.3E 7
Dibenz(a h)anthracene	0.086	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	9.8E 7
Indeno(1 2 3 cd)pyrene	0.26	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.0E 7
Total													0.0E+0	7.3E 6	

Attachment A-8 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	7.9E 9
Benzo(a)pyrene	0.19	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	6.5E 8
Benzo(b)fluoranthene	0.25	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.6E 9
Dibenz(a,h)anthracene	0.048	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.7E 8
Indeno(1,2,3 cd)pyrene	0.12	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	4.1E 9
															Total	0.0E+0	1.0E 7

Attachment A-8-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.23	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	9.7E 8
Benzo(a)pyrene	0.19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	8.0E 7
Benzo(b)fluoranthene	0.25	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	1.1E 7
Dibenz(a,h)anthracene	0.048	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	2.0E 7
Indeno(1,2,3 cd)pyrene	0.12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	5.1E 8
Total														0.0E+0	1.3E 6

Attachment A-8-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Northeast Parking Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 3E 9	3 7E 8
Ingestion	0	0	2 6E 9	3 2E 8
Total	0	0	3 9E 9	6 8E 8
Future Industrial/Commercial Worker				
Dermal	0	0	1 2E 8	1 4E 6
Ingestion	0	0	7 6E 8	1 6E 6
Total	0	0	8 8E 8	3 0E 6
Current Trespasser/Site Visitor				
Dermal	0	0	6 8E 10	1 2E 7
Ingestion	0	0	3 3E 9	9 4E 8
Total	0	0	4 0E 9	2 1E 7
Hypothetical Future Resident				
Dermal	0	0	1 0E 7	4 7E 6
Ingestion	0	0	1 3E 6	7 3E 6
Total	0	0	1 4E 6	1 2E 5

Attachment A 9-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Rail Line Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg-day) ¹	Background
Arsenic	mg/kg	4.5	9.5	11/11	7.2	6.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.48	0.9	11/11	0.68	0.62	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.011	0.083	6/11	0.066	0.037	0.13	NTV	7.3E+00	0.74

Rail Line Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	2.7	9.5	33/33	6.1	5.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.47	1.3	33/33	0.72	0.65	0	5.0E-03	NTV	1.01
Chromium	mg/kg	14	48	33/33	26.7	23.9	0	2.0E-02	NTV	25.5
Benzo(a)pyrene	mg/kg	0.006	0.19	11/33	0.046	0.037	0.13	NTV	7.3E+00	0.74

¹ Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-9-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.72	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E-03	NTV	0.0E+0	NA
Chromium	26.7	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E-02	NTV	0.0E+0	NA
Benzo(a)pyrene	0.046	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	4.3E-9
													Total	0.0E+0
														4.3E-9

Attachment A-9-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.72	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	4.8E 4	NA
Chromium	26.7	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	4.5E 3	NA
Benzo(a)pyrene	0.046	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	3.7E 9
										Total	5.0E 3	3.7E 9

Attachment A-9-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_iD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	23.9	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)pyrene	0.037	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.4E 10
												Total	0.0E+0	2.4E 10

Attachment A-9-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.65	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.3E 4	NA
Chromium	23.9	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.2E 3	NA
Benzo(a)pyrene	0.037	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	4.5E 10
										Total	1.4E 3	4.5E 10

Attachment A-9-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.066	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E+00	NA	1.4E 7
												Total	0.0E+0	1.4E 7

Attachment A-9-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.066	1E 6	100	250	25	70	9.125	25.550	NTV	7.3E+00	NA	1.7E 7
										Total	0.0E+0	1.7E 7

Attachment A-9-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.037	1E 6	0.03	0.13	2.000	250	5	70	1.825	25.550	NTV	7.3E+00	NA	1.5E 9
												Total	0.0E+0	1.5E 9

Attachment A-9-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0 037	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	9 4E 9
										Total	0 0E+0	9 4E 9

Attachment A-9-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.066	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.2E-8
													Total	0.0E+0

Attachment A-9-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.066	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	9.7E-9	
											Total	0.0E+0	9.7E-9

Attachment A-9-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.037	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	8.5E-11	
													Total	0.0E+0	8.5E-11

Attachment A-9-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.037	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 1E 10
										Total	0 0E+0	4 1E 10

Attachment A-9-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad lt} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad lt} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{ad lt} \cdot ED_{ad lt} / BW_{ad lt}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad lt}	EF	ED _{child}	ED _{ad lt}	BW _{child}	BW _{ad lt}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.066	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	4.9E-7
															Total	0.0E+0	4.9E-7

Attachment A-9-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.066	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	7.5E-7	
														Total	0.0E+0	7.5E-7

Attachment A-9-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.037	1E-6	0.04	0.13	1440	2000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	1.3E-8
Total															0.0E+0	1.3E-8	

Attachment A-9-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _{nc}	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.037	1E 6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	1.6E 7	
														Total	0.0E+0	1.6E 7

Attachment A-9-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Railroad Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 4E 10	4 3E 9
Ingestion	0 0014	0 0050	4 5E 10	3 7E 9
Total	0 0014	0 0050	6 9E 10	8 1E 9
Future Industrial/Commercial Worker				
Dermal	0	0	1 5E 9	1 4E 7
Ingestion	0	0	9 4E 9	1 7E 7
Total	0	0	1 1E 8	3 1E 7
Current Trespasser/Site Visitor				
Dermal	0	0	8 5E 11	1 2E 8
Ingestion	0	0	4 1E 10	9 7E 9
Total	0	0	4 9E 10	2 2E 8
Hypothetical Future Resident				
Dermal	0	0	1 3E 8	4 9E 7
Ingestion	0	0	1 6E 7	7 5E 7
Total	0	0	1 7E 7	1 2E 6

Attachment A-10 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Roadway Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Antimony	mg/kg	2 1	34	10/32	11 1	9 6	0	4 0E-04	NTV	
Arsenic	mg/kg	0 67	11	32/32	6 8	6 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 54	6 7	32/32	1 17	0 85	0	2 0E 03	NTV	1 01
Chromium	mg/kg	17	37	32/32	24	23	0	3 0E 03	NTV	25 46
Benzo(a)pyrene	mg/kg	0 002	0 48	24/32	0 14	0 09	0 13	NTV	7 3E+00	0 74
Dibenz(a h)anthracene	mg/kg	0 003	0 084	13/32	0 037	0 031	0 13	NTV	7 3E+00	0 3

Roadway Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{rel} (mg/kg day)	Background
Antimony	mg/kg	1 8	34	30/96	9 6	8 8	0	4 0E 04	NTV	
Arsenic	mg/kg	0 67	11	96/96	5 6	5 3	0 03	NE	NE	13 22
Beryllium	mg/kg	0 46	6 7	96/96	0 85	0 75	0	5 0E 03	NTV	1 01
Chromium	mg/kg	15	37	96/96	24 4	23 7	0	2 0E 02	NTV	25 46
Benzo(a)anthracene	mg/kg	0 002	1 2	48/96	0 17	0 13	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 002	1 1	49/96	0 078	0 056	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	1 5	51/96	0 16	0 13	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 001	0 16	21/96	0 034	0 03	0 13	NTV	7 3E+00	0 3

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-10-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{o,ai}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{o,ai} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{o,ai}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	0.9	0	3 300	60	1	70	84	25 550	4.0E 04	NTV	0.0E+0	NA
Beryllium	0.85	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	24.4	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.17	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.6E 9
Benzo(a)pyrene	0.078	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	7.4E 9
Benzo(b)fluoranthene	0.16	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.5E 9
Dibenz(a,h)anthracene	0.034	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	3.2E 9
Total													0.0E+0	1.4E 8

Attachment A-10-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	330	60	1	70	84	25 550	4 0E 04	NTV	8.1E 2	NA
Beryllium	0.85	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	5.7E 4	NA
Chromium	24.4	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	4.1E 3	NA
Benzo(a)anthracene	0.17	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.4E 9
Benzo(a)pyrene	0.078	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	6.3E 9
Benzo(b)fluoranthene	0.16	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.3E 9
Dibenz(a h)anthracene	0.034	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	2.7E 9
										Total	8.5E 2	1.2E 8

Attachment A-10 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	8.8	1E 6	0.2	0	2 000	30	1	70	42	25 550	4.0E 04	NTV	0.0E+0	NA
Beryllium	0.75	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	23.7	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.13	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	8.3E 11
Benzo(a)pyrene	0.056	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.6E 10
Benzo(b)fluoranthene	0.13	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	8.3E 11
Dibenz(a,h)anthracene	0.03	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.9E 10
Total												0.0E+0	7.1E 10	

Attachment A-10-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	8.8	1E 6	100	30	1	70	42	25 550	4.0E 04	NTV	2.2E 2	NA
Beryllium	0.75	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.5E 4	NA
Chromium	23.7	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.2E 3	NA
Benzo(a)anthracene	0.13	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.6E 10
Benzo(a)pyrene	0.056	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	6.9E 10
Benzo(b)fluoranthene	0.13	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.6E 10
Dibenz(a h)anthracene	0.03	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	3.7E 10
Total										2.4E 2	1.4E 9	

Attachment A-10-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	111	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	1 17	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 14	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 7
Dibenz(a h)anthracene	0 037	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	8 1E 8
												Total	0 0E+0	3 9E 7

Attachment A-10-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	11.1	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	2.7E 2	NA
Beryllium	1.17	1E 6	100	250	25	70	9 125	25 550	2.0E 03	NTV	5.7E 4	NA
Chromium	24	1E 6	100	250	25	70	9 125	25 550	3.0E 03	NTV	7.8E 3	NA
Benzo(a)pyrene	0.14	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	3.6E 7
Dibenz(a,h)anthracene	0.037	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	9.4E 8
											Total	3.6E 2
												4.5E 7

Attachment A-10-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	4.0E-04	NTV	0.0E+0	NA
Beryllium	0.85	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	2.0E-03	NTV	0.0E+0	NA
Chromium	23	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)pyrene	0.09	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	3.6E-9
Dibenz(a,h)anthracene	0.031	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	1.2E-9
												Total	0.0E+0	4.8E-9

Attachment A-10-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	50	250	5	70	1 825	25 550	4.0E 04	NTV	1.2E 2	NA
Beryllium	0.85	1E 6	50	250	5	70	1 825	25 550	2.0E 03	NTV	2.1E 4	NA
Chromium	23	1E 6	50	250	5	70	1 825	25 550	3.0E 03	NTV	3.8E 3	NA
Benzo(a)pyrene	0.09	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.3E 8
Dibenz(a h)anthracene	0.031	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	7.9E 9
										Total	1.6E 2	3.1E 8

Attachment A-10-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 04	NTV	0 0E+0	NA
Beryllium	1 17	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 14	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 6E 8
Dibenz(a h)anthracene	0 037	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 0E 9
												Total	0 0E+0	3 3E 8

Attachment A-10-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	11 1	1E 6	100	12	30	70	10 950	25 550	4 0E 04	NTV	1 3E 3	NA
Beryllium	1 17	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	2 7E 5	NA
Chromium	24	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	3 8E 4	NA
Benzo(a)pyrene	0 14	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 1E 8
Dibenz(a h)anthracene	0 037	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 4E 9
										Total	1 7E 3	2 6E 8

Attachment A-10-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	4.0E 04	NTV	0.0E+0	NA
Beryllium	0.85	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	23	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)pyrene	0.09	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.1E 10
Dibenz(a,h)anthracene	0.031	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	7.1E 11
												Total	0.0E+0	2.8E 10

Attachment A-10-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x 10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	50	6	9	70	3 285	25 550	4 0E 04	NTV	2.8E 4	NA
Beryllium	0.85	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	5.0E 6	NA
Chromium	23	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	9.0E 5	NA
Benzo(a)pyrene	0.09	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	9.9E 10
Dibenz(a,h)anthracene	0.031	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	3.4E 10
										Total	3.8E 4	1.3E 9

Attachment A-10 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{-})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{-} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD ₋	SF ₋	Hazard Index	Cancer Risk
Antimony	11.1	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4.0E 04	NTV	0	NA
Beryllium	1.17	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	0	NA
Chromium	24	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0	NA
Benzo(a)pyrene	0.14	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.0E 6
Dibenz(a,h)anthracene	0.037	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.7E 7
Total																0.0E+0	1.3E 6

Attachment A-10 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	11 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	3 5E 1	NA	
Beryllium	1 17	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	7 5E 3	NA	
Chromium	24	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 0E 1	NA	
Benzo(a)pyrene	0 14	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6	
Dibenz(a h)anthracene	0 037	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 2E 7	
														Total	4 6E 1	2 0E 6

Attachment A-10 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child}) / BW_{child}) + (SA_{adult} \cdot ED_{adult}) / BW_{adult})) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4.0E-04	NTV	0.0E+0	NA
Beryllium	0.85	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-03	NTV	0.0E+0	NA
Chromium	.23	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)pyrene	0.09	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.1E-8
Dibenz(a,h)anthracene	0.031	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.1E-8
															Total	0.0E+0	4.2E-8

Attachment A-10-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	9.6	1E 6	100	50	350	6	3	15	70	2 190	25 550	4.0E 04	NTV	1.5E 1	NA
Beryllium	0.85	1E 6	100	50	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	2.7E 3	NA
Chromium	23	1E 6	100	50	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	4.9E 2	NA
Benzo(a)pyrene	0.09	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.8E 7
Dibenz(a,h)anthracene	0.031	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.3E 7
Total														2.1E 1	5.1E 7

Attachment A-10-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Roadway Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	7 1E 10	1 4E 8
Ingestion	0 024	0 085	1 4E 9	1 2E 8
Total	0 024	0 085	2 1E 9	2 5E 8
Future Industrial/Commercial Worker				
Dermal	0	0	4 8E 9	3 9E 7
Ingestion	0 016	0 036	3 1E 8	4 5E 7
Total	0 016	0 036	3 6E 8	8 4E 7
Current Trespasser/Site Visitor				
Dermal	0	0	2 8E 10	3 3E 8
Ingestion	0 00038	0 0017	1 3E 9	2 6E 8
Total	0 00038	0 0017	1 6E 9	5 9E 8
Hypothetical Future Resident				
Dermal	0	0	4 2E 8	1 3E 6
Ingestion	0 21	0 46	5 1E 7	2 0E 6
Total	0 21	0 46	5 5E 7	3 3E 6

Attachment A 11-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 1A Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
PCB 1254	mg/kg	0 35	0 35	1/4	0 35	0 35	0 14	2 00E 05	2/1 ^a	
Arsenic	mg/kg	~4 5	~4 5	1/1	4 5	4 5	0 03	NE	NE	13 22
Beryllium	mg/kg	0 57	0 57	1/1	0 57	0 57	0	NE	NE	1 01

Hotspot 1A Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
PCB 1254	mg/kg	0 35	0 35	1/6	0 21	0 10	0 14	5 00E-05	2/1 ^a	
Arsenic	mg/kg	~4 5	~5 8	3/3	5 8	5 10	0 03	NE	NE	13 22
Beryllium	mg/kg	0 38	0 66	3/3	0 66	0 54	0	NE	NE	1 01

^a Present at background level

^a IRIS recommends using a slope factor of 2 0 for RME and 1 0 for CTE

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-11-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
PCB 1254	0.21	1E 6	0.9	0.14	3.300	60	1	70	84	25.550	5.0E 05	2.0E+00	1.8E 2	5.8E 9	
													Total	1.8E 2	5.8E 9

Attachment A-11-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.21	1E 6	330	60	1	70	84	25 550	5.0E-05	2.0E+00	1.4E-02	4.6E-09
								Total			1.4E-02	4.6E-09

Attachment A-11-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
PCB 1254	0.10	1E 6	0.2	0.14	2.000	30	1	70	42	25.550	5.0E 05	1.0E+00	1.2E 3	9.5E 11	
													Total	1.2E 3	9.5E 11

Attachment A-11-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.10	1E 6	100	30	1	70	42	25 550	5.0E 05	1.0E+00	2.1E 3	1.7E 10
										Total	2.1E 3	1.7E 10

Attachment A-11-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	0.20	0.14	3 300	250	25	70	9 125	25 550	2 0E 05	2	1.6E 2	2.3E 7
												Total	1.6E 2	2.3E 7

Attachment A-11-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	100	250	25	70	9 125	25 550	2.0E 05	2	1.7E 2	2.4E 7
										Total	1.7E 2	2.4E 7

Attachment A-11-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	0.03	0.14	2.000	250	5	70	1.825	25.550	2.0E 05	1	1.4E 3	2.1E 9
												Total	1.4E 3	2.1E 9

Attachment A-11-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	50	250	5	70	1 825	25 550	2.0E 05	1	8.6E 3	1.2E 8
										Total	8.6E 3	1.2E 8

Attachment A-11-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
PCB 1254	0.35	1E 6	0.3	0.14	3 300	12	30	70	10 950	25 550	2 0E 05	2	1.1E 3	2.0E 8	
													Total	1.1E 3	2.0E 8

Attachment A-11-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2	8.2E 4	1.4E 8
Total											8.2E 4	1.4E 8

Attachment A-11-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	0.04	0.14	2.000	6	9	70	3.285	25.550	2.0E 05	1	4.6E 5	1.2E 10
												Total	4.6E 5	1.2E 10

Attachment A-11-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	50	6	9	70	3 285	25 550	2.0E 05	1	2.1E 4	5.3E 10
										Total	2.1E 4	5.3E 10

Attachment A-11-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	0.3	0.14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2	9.0E 2	7.6E 7
															Total	9.0E 2	7.6E 7

Attachment A-11-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR}_{\text{child}} \text{ EF ED}_{\text{child}}) / (\text{BW}_{\text{child}} \text{ AT}_c \text{ RfD}_{\text{oral}})$$

(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

CF = Conversion Factor (1×10^6 kg/mg)

IR_{child} = Soil Ingestion Rate for a Child (mg/day)

IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF EF SF}_{\text{oral}} ((\text{IR}_{\text{child}} \text{ ED}_{\text{child}} / \text{BW}_{\text{child}}) + (\text{IR}_{\text{adult}} \text{ ED}_{\text{adult}} / \text{BW}_{\text{adult}}))) / (\text{AT}_c)$$

(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
PCB 1254	0.35	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2	2.2E 1	1.1E 6	
														Total	2.2E 1	1.1E 6

Attachment A-11-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{ad} \cdot ED_{ad} / BW_{ad}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{ad}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.35	1E 6	0.04	0.14	1.440	2.000	350	6	3	15	70	2.190	25.550	2.0E 05	1	9.0E 3	1.8E 8
															Total	9.0E 3	1.8E 8

Attachment A-11-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
PCB 1254	0.35	1E 6	100	50	350	6	3	15	70	2190	25 550	2.0E 05	1	1.1E 1	2.0E 7	
														Total	1.1E 1	2.0E 7

Attachment A-11-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0012	0 018	9 5E 11	5 8E 9
Ingestion	0 0021	0 014	1 7E 10	4 6E 9
Total	<u>0 0032</u>	<u>0 031</u>	<u>2 7E 10</u>	<u>1 0E 8</u>
Future Industrial/Commercial Worker				
Dermal	0 0014	0 016	2 1E 9	2 3E 7
Ingestion	0 0086	0 017	1 2E 8	2 4E 7
Total	<u>0 010</u>	<u>0 033</u>	<u>1 4E 8</u>	<u>4 7E 7</u>
Current Trespasser/Site Visitor				
Dermal	0 000046	0 0011	1 2E 10	2 0E 8
Ingestion	0 00021	0 00082	5 3E 10	1 4E 8
Total	<u>0 00025</u>	<u>0 0020</u>	<u>6 5E 10</u>	<u>3 4E 8</u>
Hypothetical Future Resident				
Dermal	0 0090	0 090	1 8E 8	7 6E 7
Ingestion	0 11	0 22	2 0E 7	1 1E 6
Total	<u>0 12</u>	<u>0 31</u>	<u>2 2E 7</u>	<u>1 9E 6</u>

Attachment A-12 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 1B Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	5.7	8.7	2/2	8.7	7.20	0.03	NE	NE	13.22
Beryllium	mg/kg	0.6	0.63	2/2	0.63	0.62	0	NE	NE	1.01
Chromium	mg/kg	21	46	2/2	46	34	0	3.0E 03	NTV	25.46
Copper	mg/kg	15	1260	2/2	1260	638	0	4.0E 02	NTV	59.1
Benzo(a)anthracene	mg/kg	0.71	1.7	2/2	1.7	1.21	0.13	NTV	0.73	0.89
Benzo(a)pyrene	mg/kg	0.53	1.2	2/2	1.2	0.87	0.13	NTV	7.3	0.74
Benzo(b)fluoranthene	mg/kg	0.7	1.7	2/2	1.7	1.20	0.13	NTV	0.73	0.63
Dibenz(a,h)anthracene	mg/kg	0.090	0.29	2/2	0.29	0.19	0.13	NTV	7.3	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.28	0.7	2/2	0.7	0.49	0.13	NTV	0.73	0.41

Hotspot 1B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{rel} (mg/kg-day) ¹	Background
Arsenic	mg/kg	3.4	8.7	6/6	7.2	5.60	0.03	NE	NE	13.22
Beryllium	mg/kg	0.53	0.63	6/6	0.61	0.59	0	NE	NE	1.01
Chromium	mg/kg	18	46	6/6	33.9	25.5	0	2.0E 02	NTV	25.46
Copper	mg/kg	9.6	1260	6/6	640	221	0	4.0E 02	NTV	59.1
Benzo(a)anthracene	mg/kg	0.065	1.7	3/6	0.96	0.46	0.13	NTV	0.73	0.89
Benzo(a)pyrene	mg/kg	0.053	1.2	3/6	0.71	0.31	0.13	NTV	7.3	0.74
Benzo(b)fluoranthene	mg/kg	0.045	1.7	3/6	0.99	0.47	0.13	NTV	0.73	0.63
Dibenz(a,h)anthracene	mg/kg	0.09	0.29	2/6	0.17	0.084	0.13	NTV	7.3	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.035	0.7	3/6	1.4	0.26	0.13	NTV	0.73	0.41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-12-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	33.9	1E 6	0.9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA	
Copper	640	1E 6	0.9	0	3 300	60	1	70	84	25 550	4 0E 02	NTV	0 0E+0	NA	
Benzo(a)anthracene	0.96	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	9.1E 9	
Benzo(a)pyrene	0.71	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	6.7E 8	
Benzo(b)fluoranthene	0.99	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	9.4E 9	
Dibenz(a h)anthracene	0.17	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.6E 8	
Indeno(1 2 3 cd)pyrene	1.4	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.3E 8	
													Total	0 0E+0	1 1E 7

Attachment A-12-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_{ref}D_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.9	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	5.7E 3	NA
Copper	640	1E 6	330	60	1	70	84	25 550	4.0E 02	NTV	5.4E 2	NA
Benzo(a)anthracene	0.96	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	7.8E 9
Benzo(a)pyrene	0.71	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	5.7E 8
Benzo(b)fluoranthene	0.99	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	8.0E 9
Dibenz(a,h)anthracene	0.17	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.4E 8
Indeno(1,2,3 cd)pyrene	1.4	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.1E 8
Total											6.0E 2	9.8E 8

Attachment A-12-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	25.5	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Copper	221	1E 6	0.2	0	2 000	30	1	70	42	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.46	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.9E 10
Benzo(a)pyrene	0.31	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.0E 9
Benzo(b)fluoranthene	0.47	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	3.0E 10
Dibenz(a,h)anthracene	0.084	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	5.3E 10
Indeno(1,2,3 cd)pyrene	0.26	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	1.7E 10
Total													0.0E+0	3.3E 9

Attachment A-12-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	25.5	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 3E 3	NA
Copper	221	1E 6	100	30	1	70	42	25 550	4 0E 02	NTV	5 6E 3	NA
Benzo(a)anthracene	0.46	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 6E 10
Benzo(a)pyrene	0.31	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	3 8E 9
Benzo(b)fluoranthene	0.47	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 8E 10
Dibenz(a h)anthracene	0.084	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 0E 9
Indeno(1 2 3 cd)pyrene	0.26	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	3 2E 10
										Total	6 9E 3	6 3E 9

Attachment A-12-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	1260	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 7E 7
Benzo(a)pyrene	1 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 6E 6
Benzo(b)fluoranthene	1 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	3 7E 7
Dibenz(a h)anthracene	0 29	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	6 3E 7
Indeno(1 2 3 cd)pyrene	0 7	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 5E 7
Total												0 0E+0	4 2E 6	

Attachment A-12-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{o\ al}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
Chromium	46	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 5E 2	NA
Copper	1260	1E 6	100	250	25	70	9 125	25 550	4 0E 02	NTV	3 1E 2	NA
Benzo(a)anthracene	1 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 3E 7
Benzo(a)pyrene	1 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 6
Benzo(b)fluoranthene	1 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 3E 7
Dibenz(a h)anthracene	0 29	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 4E 7
Indeno(1 2 3 cd)pyrene	0 7	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 8E 7
Total										4 6E 2	4 8E 6	

Attachment A-12 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.5	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 03	NTV	0.0E+0	NA
Copper	638	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	1.21	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.8E 9
Benzo(a)pyrene	0.87	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	3.4E 8
Benzo(b)fluoranthene	1.2	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.8E 9
Dibenz(a h)anthracene	0.19	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	7.6E 9
Indeno(1 2 3 cd)pyrene	0.49	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	2.0E 9
												Total	0.0E+0	5.4E 8

Attachment A-12-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _{nc}	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.5	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5.5E 3	NA
Copper	638	1E 6	50	250	5	70	1 825	25 550	4 0E 02	NTV	7.8E 3	NA
Benzo(a)anthracene	1.21	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.1E 8
Benzo(a)pyrene	0.87	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.2E 7
Benzo(b)fluoranthene	1.2	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.1E 8
Dibenz(a h)anthracene	0.19	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.8E 8
Indeno(1 2 3 cd)pyrene	0.49	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	1.3E 8
Total										1 3E 2	3.4E 7	

Attachment A-12-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Copper	1260	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 2E 8
Benzo(a)pyrene	1 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 3E 7
Benzo(b)fluoranthene	1 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 2E 8
Dibenz(a h)anthracene	0 29	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 5E 8
Indeno(1 2 3 cd)pyrene	0 7	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 3E 8
Total													0 0E+0	3 6E 7

Attachment A-12-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	7 2E 4	NA
Copper	1260	1E 6	100	12	30	70	10 950	25 550	4 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	1 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 5E 8
Benzo(a)pyrene	1 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 8E 7
Benzo(b)fluoranthene	1 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 5E 8
Dibenz(a h)anthracene	0 29	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 3E 8
Indeno(1 2 3 cd)pyrene	0 7	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 0E 8
Total										2 2E 3	2 8E 7	

Attachment A-12-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.5	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 03	NTV	0.0E+0	NA
Copper	638	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	4.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	1.21	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.8E 10
Benzo(a)pyrene	0.87	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.0E 9
Benzo(b)fluoranthene	1.2	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.8E 10
Dibenz(a h)anthracene	0.19	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	4.4E 10
Indeno(1 2 3 cd)pyrene	0.49	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.1E 10
Total													0.0E+0	3.1E 9

Attachment A-12-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.5	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1.3E 4	NA
Copper	638	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	1.9E 4	NA
Benzo(a)anthracene	1.21	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.3E 9
Benzo(a)pyrene	0.87	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	9.5E 9
Benzo(b)fluoranthene	1.2	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.3E 9
Dibenz(a h)anthracene	0.19	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.1E 9
Indeno(1 2 3 cd)pyrene	0.49	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	5.4E 10
Total										3.2E 4	1.5E 8	

Attachment A 12 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{rel})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor: (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT \cdot SF_{rel})$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Chromium	46	1E-6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E-03	NTV	0	NA
Copper	1260	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4.0E-02	NTV	0	NA
Benzo(a)anthracene	1.7	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	1.3E 6
Benzo(a)pyrene	1.2	1E-6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.9E 6
Benzo(b)fluoranthene	1.7	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E-01	NA	1.3E 6
Dibenz(a h)anthracene	0.29	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.1E 6
Indeno(1 2 3 cd)pyrene	0.7	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	5.2E 7
Total																0.0E+0	1.4E 5

Attachment A-12-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	46	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	2 0E 1	NA
Copper	1260	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 02	NTV	4 0E 1	NA
Benzo(a)anthracene	1 7	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 9E 6
Benzo(a)pyrene	1 2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 5
Benzo(b)fluoranthene	1 7	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	1 9E 6
Dibenz(a h)anthracene	0 29	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 3E 6
Indeno(1 2 3-cd)pyrene	0 7	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	8 0E 7
Total														6 0E 1	2 2E 5

Attachment A 12 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_{nc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Chromium	33.5	1E-6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	0.0E+0	NA
Copper	638	1E-6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4.0E-02	NTV	0.0E+0	NA
Benzo(a)anthracene	1.21	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	4.1E-8
Benzo(a)pyrene	0.87	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.0E-7
Benzo(b)fluoranthene	1.2	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	4.1E-8
Dibenz(a,h)anthracene	0.19	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	6.5E-8
Indeno(1,2,3-cd)pyrene	0.49	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.7E-8
Total																0.0E+0	4.6E-7

Attachment A-12 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} \cdot BW_{child}) + (IR_{adult} \cdot ED_{adult} \cdot BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	33.5	1E 6	100	50	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	7.1E 2	NA
Copper	638	1E 6	100	50	350	6	3	15	70	2 190	25 550	4.0E-02	NTV	1.0E 1	NA
Benzo(a)anthracene	1.21	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	5.1E 7
Benzo(a)pyrene	0.87	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.6E 6
Benzo(b)fluoranthene	1.2	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	5.1E 7
Dibenz(a h)anthracene	0.19	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	8.0E 7
Indeno(1 2 3-cd)pyrene	0.49	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	2.1E 7
Total														1.7E 1	5.7E 6

Attachment A-12-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	3 3E 9	1 1E 7
Ingestion	0 0069	0 060	6 3E 9	9 8E 8
Total	0 0069	0 060	9 5E 9	2 1E 7
Future Industrial/Commercial Worker				
Dermal	0	0	5 4E 8	4 2E 6
Ingestion	0 013	0 046	3 4E 7	4 8E 6
Total	0 013	0 046	4 0E 7	9 0E 6
Current Trespasser/Site Visitor				
Dermal	0	0	3 1E 9	3 6E 7
Ingestion	0 00032	0 0022	1 5E 8	2 8E 7
Total	0 00032	0 0022	1 8E 8	6 4E 7
Hypothetical Future Resident				
Dermal	0	0	4 6E 7	1 4E 5
Ingestion	0 17	0 60	5 7E 6	2 2E 5
Total	0 17	0 60	6 1E 6	3 6E 5

Attachment A-13-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 1C Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	7 5	14	2/2	14	10 75	0 03	3 0E 04	1 5	13 22
Beryllium	mg/kg	0 67	0 67	1/1	0 67	0 67	0	NE	NE	1 01

Hotspot 1C Combined Surface and Subsurface Soil (0 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	7 5	14	4/4	14	9 30	0 03	3 0E 04	1 5	13 22
Beryllium	mg/kg	0 67	0 69	3/3	0 69	0 68	0	NE	NE	1 01

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-13-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	3 0E 04	1 5E+00	4 2E 2	6 3E 8	
													Total	4 2E 2	6 3E 8

Attachment A-13-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	330	60	1	70	84	25 550	3 0E 04	1 5E+00	1 6E 1	2 3E 7	
											Total	1 6E 1	2 3E 7

Attachment A-13-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where¹ HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	9.3	1E 6	0.2	0.03	2.000	30	1	70	42	25.550	3.0E 04	1.5E+00	3.8E 3	2.8E 9	
													Total	3.8E 3	2.8E 9

Attachment A-13-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Arsenic	9.3	1E 6	100	30	1	70	42	25 550	3.0E 04	1.5E+00	3.2E 2	2.3E 8
										Total	3.2E 2	2.3E 8

Attachment A-13-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	3 0E 04	1 5E+00	9 0E 3	1 5E 6	
													Total	9 0E 3	1 5E 6

Attachment A-13-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	100	250	25	70	9 125	25 550	3 0E 04	1 5E+00	4 6E 2	7 3E 6	
											Total	4 6E 2	7 3E 6

Attachment A-13-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	11	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	3 0E 04	1 5E+00	6 3E 4	2 0E 8	
													Total	6 3E 4	2 0E 8

Attachment A-13-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	11	1E 6	50	250	5	70	1 825	25 550	3 0E 04	1 5E+00	1 8E 2	5 6E 7	
											Total	1 8E 2	5 6E 7

Attachment A-13-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	3 0E 04	1 5E+00	6 5E 4	1 3E 7	
													Total	6 5E 4	1 3E 7

Attachment A-13-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	100	12	30	70	10 950	25 550	3 0E 04	1 5E+00	2 2E 3	4 2E 7	
											Total	2 2E 3	4 2E 7

Attachment A-13-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	11	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	3 0E 04	1 5E+00	2 0E 5	1 2E 9	
													Total	2 0E 5	1 2E 9

Attachment A-13-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT_{nc}	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk	
Arsenic	11	1E 6	50	6	9	70	3 285	25 550	3 0E 04	1 5E+00	4 2E 4	2 4E 8	
											Total	4 2E 4	2 4E 8

Attachment A-13-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	RfD	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E+00	0 05136274	4 9E 6
															Total	5 1E 2	4 9E 6

Attachment A-13-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	14	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 04	1 5E+00	6 0E 1	3 3E 5	
														Total	6 0E 1	3 3E 5

Attachment A-13-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

- Where HI = Hazard Index (unitless)
- CS = Concentration of Chemical in Soil (mg/kg)
- CF = Conversion Factor (1×10^6 kg/mg)
- AD = Adherence Factor for Soil (mg/cm²)
- AB = Absorbed Fraction (unitless)
- SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
- SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
- EF = Exposure Frequency (days/year)
- ED_{child} = Exposure Duration for a Child (years)
- ED_{adult} = Exposure Duration for an Adult (years)
- BW_{child} = Body Weight for a Child (kg)
- BW_{adult} = Body Weight for an Adult (kg)
- AT_{nc} = Averaging Time for Non Carcinogens (days)
- RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

- Where CR = Cancer Risk (unitless)
- AT_c = Averaging Time for Carcinogens (days)
- SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA_{child}	SA_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT _c	AT	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Arsenic	11	$1E\ 6$	0 04	0 03	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E+00	4 0E 3	1 8E 7
															Total	4 0E 3	1 8E 7

Attachment A-13-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_c \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Arsenic	11	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 04	1 5E+00	2 3E 1	9 3E 6	
														Total	2 3E 1	9 3E 6

Attachment A-13-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 1C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0038	0 042	2 8E 9	6 3E 8
Ingestion	0 032	0 16	2 3E 8	2 3E 7
Total	<u>0 035</u>	<u>0 20</u>	<u>2 6E 8</u>	<u>3 0E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 00063	0 0090	2 0E 8	1 5E 6
Ingestion	0 018	0 046	5 6E 7	7 3E 6
Total	<u>0 018</u>	<u>0 055</u>	<u>5 8E 7</u>	<u>8 8E 6</u>
Current Trespasser/Site Visitor				
Dermal	0 000020	0 00065	1 2E 9	1 3E 7
Ingestion	0 00042	0 0022	2 4E 8	4 2E 7
Total	<u>0 00044</u>	<u>0 0028</u>	<u>2 6E 8</u>	<u>5 5E 7</u>
Hypothetical Future Resident				
Dermal	0 0040	0 051	1 8E 7	4 9E 6
Ingestion	0 23	0 60	9 3E 6	3 3E 5
Total	<u>0 23</u>	<u>0 65</u>	<u>9 5E 6</u>	<u>3 8E 5</u>

Attachment A 14 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 2 Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	4.90E-07	2.00E-04	17/17	9.00E-05	6.00E-05	0.03	NTV	1.5E+05	
PCB 1248	mg/kg	0.0081	14	13/19	2.4	1.2	0.14	2.0E-05	2/1	
Arsenic	mg/kg	5.1	8.7	11/11	7	6.4	0.03	NE	NE	13.22
Beryllium	mg/kg	0.47	0.77	11/11	0.67	0.62	0	NE	NE	1.01
Lead	mg/kg	8.5	721	11/11	196	80	0	NE	NE	363

Hotspot 2 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	4.90E-07	3.00E-04	35/35	8.90E-05	6.00E-05	0.03	NTV	1.5E+05	
PCB 1248	mg/kg	0.0081	14	29/51	1.1	0.56	0.14	5.0E-05	2/1	
Arsenic	mg/kg	3.8	8.7	30/30	6.6	6.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.47	0.97	30/30	0.69	0.68	0	NE	NE	1.01
Lead	mg/kg	5.5	721	30/30	80	40	0	NE	NE	363

Present at background level

Lead has no RfD or SF and is evaluated separately

The RfD for PCB 1254 was used to evaluate PCB 1248

NE Not evaluated quantitatively

NTV No toxicity value

IRIS recommends using a slope factor of 2.0 for RME and 1.0 for CTE

Attachment A-14-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000089	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1 5E+05	NA	4 0E 8	
PCB 1248	1 1	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5 0E 05	2 0E+00	9 3E 2	3 1E 8	
													Total	9 3E 2	7 1E 8

Attachment A-14-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000089	1E 6	330	60	1	70	84	25 550	NTV	1 5E+05	NA	1 5E 7	
PCB 1248	1 1	1E 6	330	60	1	70	84	25 550	5 0E 05	2 0E+00	7 4E 2	2 4E 8	
											Total	7 4E 2	1 7E 7

Attachment A-14-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000060	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	NTV	1 5E+05	NA	1 8E 9
PCB 1248	0 56	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5 0E 05	1 0E+00	6 4E 3	5 3E 10
													Total	6 4E 3
														2 3E 9

Attachment A-14-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000060	1E 6	100	30	1	70	42	25 550	NTV	1 5E+05	NA	1 5E 8	
PCB 1248	0 56	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	1 1E 2	9 4E 10	
											Total	1 1E 2	1 6E 8

Attachment A-14-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000090	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	9 3E 7	
PCB 1248	2 4	1E 6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 1E 1	1 5E 6	
													Total	1 1E 1	2 5E 6

Attachment A-14-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000090	1E 6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	4 7E 6	
PCB 1248	2 4	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 2E 1	1 7E 6	
											Total	1 2E 1	6 4E 6

Attachment A-14-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0.000060	1E 6	0.03	0.03	2.000	250	5	70	1.825	25.550	NTV	1.5E+05	NA	1.1E-8	
PCB 1248	12	1E 6	0.03	0.14	2.000	250	5	70	1.825	25.550	2.0E-05	1.0E+00	4.9E-3	7.0E-9	
													Total	4.9E-3	1.8E-8

Attachment A-14-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000060	1E 6	50	250	5	70	1 825	25 550	NTV	1 5E+05	NA	3 1E 7	
PCB 1248	1 2	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 9E 2	4 2E 8	
											Total	2 9E 2	3 6E 7

Attachment A-14-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000090	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	NTV	1 5E+05	NA	8 1E 8	
PCB 1248	2 4	1E 6	0 3	0 14	3 300	12	30	70	10 950	25 550	2 0E 05	2 0E+00	7 8E 3	1 3E 7	
													Total	7 8E 3	2 1E 7

Attachment A-14-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000090	1E 6	100	12	30	70	10 950	25 550	NTV	1 5E+05	NA	2 7E 7	
PCB 1248	2 4	1E 6	100	12	30	70	10 950	25 550	2 0E 05	2 0E+00	5 6E 3	9 7E 8	
											Total	5 6E 3	3 7E 7

Attachment A-14-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000060	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	NTV	1 5E+05	NA	6 5E 10	
PCB 1248	1 2	1E 6	0 04	0 14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 6E 4	4 1E 10	
													Total	1 6E 4	1 1E 9

Attachment A-14-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0.000060	1E 6	50	6	9	70	3.285	25 550	NTV	1.5E+05	NA	1.4E 8	
PCB 1248	1.2	1E 6	50	6	9	70	3.285	25 550	2.0E 05	1.0E+00	7.0E 4	1.8E 9	
											Total	7.0E 4	1.5E 8

Attachment A-14-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	0 000090	1E 6	0 3	0 03	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	3 2E 6
PCB 1248	2 4	1E 6	0 3	0 14	1 913	3 300	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	0 61635288	5 2E 6
															Total	6 2E 1	8 4E 6

Attachment A-14-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0 000090	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	1 5E+05	NA	2 1E 5	
PCB 1248	2 4	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 05	2 0E+00	1 5E+0	7 5E 6	
														Total	1 5E+0	2 9E 5

Attachment A-14-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)

SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RID	Hazard Index	Cancer Risk	
Dioxin TEQ	0.000060	1E 6	0.04	0.03	1440	2000	350	6	3	15	70	2190	25550	NTV	1.5E+05	NA	9.8E-8
PCB 1248	12	1E 6	0.04	0.14	1440	2000	350	6	3	15	70	2190	25550	2.0E-05	1.0E+00	3.1E-2	6.1E-8
															Total	3.1E-2	1.6E-7

Attachment A-14-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Dioxin TEQ	0.000060	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	1.5E+05	NA	5.2E 6	
PCB 1248	1.2	1E 6	100	50	350	6	3	15	70	2 190	25 550	2.0E 05	1.0E+00	3.8E 1	6.9E 7	
														Total	3.8E 1	5.9E 6

Attachment A-14-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 2 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0064	0 093	2 3E 9	7 1E 8
Ingestion	0 011	0 074	1 6E 8	1 7E 7
Total	<u>0 018</u>	<u>0 17</u>	<u>1 8E 8</u>	<u>2 4E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 0049	0 11	1 8E 8	2 5E 6
Ingestion	0 029	0 12	3 6E 7	6 4E 6
Total	<u>0 034</u>	<u>0 23</u>	<u>3 7E 7</u>	<u>8 9E 6</u>
Current Trespasser/Site Visitor				
Dermal	0 00016	0 0078	1 1E 9	2 1E 7
Ingestion	0 00070	0 0056	1 5E 8	3 7E 7
Total	<u>0 00086</u>	<u>0 013</u>	<u>1 6E 8</u>	<u>5 8E 7</u>
Hypothetical Future Resident				
Dermal	0 031	0 62	1 6E 7	8 4E 6
Ingestion	0 38	1 5	5 9E 6	2 9E 5
Total	<u>0 41</u>	<u>2 2</u>	<u>6 0E 6</u>	<u>3 7E 5</u>

Attachment A-15-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 4A Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	5.7	5.7	1/1	5.7	5.7	0.03	NE	NE	13.22
Beryllium	mg/kg	0.7	0.7	1/1	0.7	0.7	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	0.91	0.91	1/1	0.91	0.91	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.78	0.78	1/1	0.78	0.78	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.92	0.92	1/1	0.92	0.92	0.13	NTV	7.3E 01	0.63
Dibenz(a,h)anthracene	mg/kg	0.11	0.11	1/1	0.11	0.11	0.13	NTV	7.3E+00	0.3

Hotspot 4A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.4	5.7	3/3	5.7	4.87	0.03	NE	NE	13.22
Beryllium	mg/kg	0.7	0.95	3/3	0.95	0.83	0	NE	NE	1.01
Chromium	mg/kg	24	34	3/3	34	29	0	2.0E 02	NTV	25.46
Benzo(a)anthracene	mg/kg	0.0030	0.91	3/3	0.91	0.37	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.16	0.78	2/3	0.78	0.32	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.004	0.92	3/3	0.92	0.37	0.13	NTV	7.3E 01	0.63
Dibenz(a,h)anthracene	mg/kg	0.028	0.11	2/3	0.11	0.06	0.13	NTV	7.3E+00	0.3

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-15-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	34	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 91	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	8 6E 9
Benzo(a)pyrene	0 78	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	7 4E 8
Benzo(b)fluoranthene	0 92	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	8 7E 9
Dibenz(a h)anthracene	0 11	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 0E 8
													Total	0 0E+0
														1 0E 7

Attachment A-15-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	34	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 7E 3	NA
Benzo(a)anthracene	0 91	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 4E 9
Benzo(a)pyrene	0 78	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	6 3E 8
Benzo(b)fluoranthene	0 92	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	7 4E 9
Dibenz(a h)anthracene	0 11	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	8 9E 9
											Total	5 7E 3
												8 7E 8

Attachment A-15-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	29	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	0 37	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 4E 10
Benzo(a)pyrene	0 32	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 1E 9
Benzo(b)fluoranthene	0 37	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	2 3E 10
Dibenz(a h)anthracene	0 056	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 6E 10
												Total	0 0E+0	2 9E 9

Attachment A-15-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	29	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	0 37	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 6E 10
Benzo(a)pyrene	0 32	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 0E 9
Benzo(b)fluoranthene	0 37	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	4 5E 10
Dibenz(a h)anthracene	0 056	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 9E 10
										Total	1 5E 3	5 6E 9

Attachment A-15-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{nc} \text{ RfD}_{oral})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{oral}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.0E 7
Benzo(a)pyrene	0.78	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.7E 6
Benzo(b)fluoranthene	0.92	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.0E 7
Dibenz(a h)anthracene	0.11	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.4E 7
												Total	0.0E+0	2.3E 6

Attachment A-15-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.3E 7
Benzo(a)pyrene	0.78	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.0E 6
Benzo(b)fluoranthene	0.92	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.3E 7
Dibenz(a h)anthracene	0.11	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	2.8E 7
										Total	0.0E+0	2.7E 6

Attachment A-15-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.6E 9
Benzo(a)pyrene	0.78	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	3.1E 8
Benzo(b)fluoranthene	0.92	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	3.7E 9
Dibenz(a h)anthracene	0.11	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.4E 9
												Total	0.0E+0	4.3E 8

Attachment A-15-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-8} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E-01	NA	2.3E-8
Benzo(a)pyrene	0.78	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.0E-7
Benzo(b)fluoranthene	0.92	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E-01	NA	2.3E-8
Dibenz(a,h)anthracene	0.11	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.8E-8
										Total	0.0E+0	2.7E-7

Attachment A-15-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.7E 8
Benzo(a)pyrene	0.78	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.5E 7
Benzo(b)fluoranthene	0.92	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.7E 8
Dibenz(a h)anthracene	0.11	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.1E 8
												Total	0.0E+0	2.0E 7

Attachment A-15-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.3E 8
Benzo(a)pyrene	0.78	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.1E 7
Benzo(b)fluoranthene	0.92	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.4E 8
Dibenz(a h)anthracene	0.11	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.6E 8
										Total	0.0E+0	1.6E 7

Attachment A-15-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.1E 10
Benzo(a)pyrene	0.78	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.8E 9
Benzo(b)fluoranthene	0.92	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.1E 10
Dibenz(a h)anthracene	0.11	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.5E 10
												Total	0.0E+0	2.5E 9

Attachment A-15-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.0E 9
Benzo(a)pyrene	0.78	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	8.6E 9
Benzo(b)fluoranthene	0.92	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.0E 9
Dibenz(a h)anthracene	0.11	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.2E 9
										Total	0.0E+0	1.2E 8

Attachment A 15 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)

SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	6.7E 7
Benzo(a)pyrene	0.78	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	5.8E 6
Benzo(b)fluoranthene	0.92	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	6.8E 7
Dibenz(a,h)anthracene	0.11	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.1E 7
														Total	0.0E+0		7.9E 6

Attachment A-15-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.0E 6
Benzo(a)pyrene	0.78	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.9E 6
Benzo(b)fluoranthene	0.92	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.1E 6
Dibenz(a,h)anthracene	0.11	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.3E 6
													Total	0.0E+0	1.2E 5

Attachment A-15-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)

SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)

EF = Exposure Frequency (days/year)

ED_{child} = Exposure Duration for a Child (years)

ED_{adult} = Exposure Duration for an Adult (years)

BW_{child} = Body Weight for a Child (kg)

BW_{adult} = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	3.1E 8
Benzo(a)pyrene	0.78	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	2.7E 7
Benzo(b)fluoranthene	0.92	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	3.2E 8
Di(benz(a,h)anthracene	0.11	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.8E 8
															Total	0.0E+0	3.7E 7

Attachment A-15-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.91	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	3.8E 7
Benzo(a)pyrene	0.78	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.3E 6
Benzo(b)fluoranthene	0.92	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	3.9E 7
Dibenz(a,h)anthracene	0.11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	4.6E 7
													Total	0.0E+0	4.5E 6

Attachment A-15-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 9E 9	1 0E 7
Ingestion	0 0015	0 006	5 6E 9	8 7E 8
Total	<u>0 0015</u>	<u>0 006</u>	<u>8 5E 9</u>	<u>1 9E 7</u>
Future Industrial/Commercial Worker				
Dermal	0	0	4 3E 8	2 3E 6
Ingestion	0	0	2 7E 7	2 7E 6
Total	<u>0</u>	<u>0</u>	<u>3 2E 7</u>	<u>5 1E 6</u>
Current Trespasser/Site Visitor				
Dermal	0	0	2 5E 9	2 0E 7
Ingestion	0	0	1 2E 8	1 6E 7
Total	<u>0</u>	<u>0</u>	<u>1 4E 8</u>	<u>3 6E 7</u>
Hypothetical Future Resident				
Dermal	0	0	3 7E 7	7 9E 6
Ingestion	0	0	4 5E 6	1 2E 5
Total	<u>0</u>	<u>0</u>	<u>4 9E 6</u>	<u>2 0E 5</u>

Attachment A 16-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 4B Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.6	4.6	1/1	4.6	4.6	0.03	NE	NE	13.22
Beryllium	mg/kg	0.44	0.44	1/1	0.44	0.44	0	NE	NE	1.01
Chromium	mg/kg	31	31	1/1	31	31	0	3.0E-03	NTV	25.46
Benzo(a)anthracene	mg/kg	1.3	3.6	2/2	3.6	2.5	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.91	4.1	2/2	4.1	2.5	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	1.1	4.8	2/2	4.8	3.0	0.13	NTV	7.3E-01	0.63
Dibenz(a,h)anthracene	mg/kg	0.12	0.12	1/1	0.12	0.12	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.87	3.2	2/2	3.2	2.0	0.13	NTV	7.3E-01	0.41

Hotspot 4B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{oral} (mg/kg-day) ¹	Background
Arsenic	mg/kg	0.325	0.57	3/3	5.7	4.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.44	0.84	3/3	0.84	0.68	0	NE	NE	1.01
Chromium	mg/kg	20	32	3/3	32	28	0	2.0E-02	NTV	25.46
Benzo(a)anthracene	mg/kg	0.002	3.6	3/4	3.6	1.3	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.002	4.1	3/4	4.1	1.3	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	1.1	4.8	2/4	4.8	1.6	0.13	NTV	7.3E-01	0.63
Dibenz(a,h)anthracene	mg/kg	0.12	0.12	1/3	0.12	0.061	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.002	3.2	3/4	3.2	1.1	0.13	NTV	7.3E-01	0.41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-16-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{0 al})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x 10⁻⁶ kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{0 al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{0 al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	32	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 4E 8
Benzo(a)pyrene	4 1	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 9E 7
Benzo(b)fluoranthene	4 8	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	4 5E 8
Dibenz(a h)anthracene	0 12	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	1 1E 8
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	3 0E 8
													Total	0 0E+0
														5 1E 7

Attachment A-16-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{o al})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{o al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	32	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	5 4E 3	NA
Benzo(a)anthracene	3 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 9E 8
Benzo(a)pyrene	4 1	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	3 3E 7
Benzo(b)fluoranthene	4 8	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	3 9E 8
Dibenz(a h)anthracene	0 12	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	9 7E 9
Indeno(1 2 3 cd)pyrene	3 2	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 6E 8
										Total	5 4E 3	4 3E 7

Attachment A-16-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_c \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	28	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	1 3	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 1E 10
Benzo(a)pyrene	1 3	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	8 0E 9
Benzo(b)fluoranthene	1 6	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	9 9E 10
Dibenz(a h)anthracene	0 061	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	3 9E 10
Indeno(1 2 3 cd)pyrene	1 1	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	6 7E 10
												Total	0 0E+0	1 1E 8

Attachment A-16-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_c RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	28	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 4E 3	NA
Benzo(a)anthracene	1 3	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 6E 9
Benzo(a)pyrene	1 3	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 5E 8
Benzo(b)fluoranthene	1 6	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 9E 9
Dibenz(a h)anthracene	0 061	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 4E 10
Indeno(1 2 3 cd)pyrene	1 1	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 3E 9
										Total	1 4E 3	2 1E 8

Attachment A-16-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 9E 7
Benzo(a)pyrene	4 1	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	9 0E 6
Benzo(b)fluoranthene	4 8	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 1E 6
Dibenz(a h)anthracene	0 12	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	2 6E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E 01	NA	7 0E 7
Total													0 0E+0	1 2E 5

Attachment A-16-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_{if}D_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
Benzo(a)anthracene	3 6	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 2E 7
Benzo(a)pyrene	4 1	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 0E 5
Benzo(b)fluoranthene	4 8	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	1 2E 6
Dibenz(a h)anthracene	0 12	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 1E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 2E 7
											Total	1 0E 2
												1 4E 5

Attachment A-16-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 8E 9
Benzo(a)pyrene	2 5	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 0E 7
Benzo(b)fluoranthene	3 0	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 2E 8
Dibenz(a h)anthracene	0 12	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 9
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	8 1E 9
Total												0 0E+0	1 3E 7	

Attachment A-16-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 1E 3	NA
Benzo(a)anthracene	2 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 3E 8
Benzo(a)pyrene	2 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	6 4E 7
Benzo(b)fluoranthene	3 0	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	7 5E 8
Dibenz(a h)anthracene	0 12	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 8
Indeno(1 2 3 cd)pyrene	2 0	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	5 2E 8
										Total	5 1E 3	8 6E 7

Attachment A-16-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{0 al})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{0 al} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{0 al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{0 al}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	3 6	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 8E 8
Benzo(a)pyrene	4 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	7 8E 7
Benzo(b)fluoranthene	4 8	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	9 1E 8
Dibenz(a h)anthracene	0 12	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 3E 8
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	6 1E 8
												Total	0 0E+0	1 0E 6

Attachment A-16-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA
Benzo(a)anthracene	3 6	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	5 3E 8
Benzo(a)pyrene	4 1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 0E 7
Benzo(b)fluoranthene	4 8	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	7 1E 8
Dibenz(a h)anthracene	0 12	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 8E 8
Indeno(1 2 3 cd)pyrene	3 2	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 7E 8
Total										4 9E 4	7 9E 7	

Attachment A-16-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 6E 10
Benzo(a)pyrene	2 5	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 7E 9
Benzo(b)fluoranthene	3 0	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	6 8E 10
Dibenz(a h)anthracene	0 12	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 10
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	4 7E 10
												Total	0 0E+0	7 7E 9

Attachment A-16-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA
Benzo(a)anthracene	2 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 7E 9
Benzo(a)pyrene	2 5	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 8
Benzo(b)fluoranthene	3 0	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 3E 9
Dibenz(a h)anthracene	0 12	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 3E 9
Indeno(1 2 3 cd)pyrene	2 0	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 2E 9
										Total	1 2E 4	3 7E 8

Attachment A 16 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{-1})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{ad} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD₋₁ = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_{carc})$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_{carc} = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _{carc}	RfD ₋₁	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	0	NA
Benzo(a)anthracene	3 6	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 7E 6
Benzo(a)pyrene	4 1	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	3 0E 5
Benzo(b)fluoranthene	4 8	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 6E 6
Dibenz(a,h)anthracene	0 12	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 9E 7
Indeno(1 2 3 cd)pyrene	3 2	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 4E 6
Total																0 0E+0	4 0E 5

Attachment A-16 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA
Benzo(a)anthracene	3.6	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	4 1E 6
Benzo(a)pyrene	4.1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	4 7E 5
Benzo(b)fluoranthene	4.8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	5 5E 6
Dibenz(a h)anthracene	0.12	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 4E 6
Indeno(1 2 3 cd)pyrene	3.2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	3 7E 6
Total														1 3E 1	6 1E 5

Attachment A 16 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{ref})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{ref} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{ref}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	2 5	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 4E 8
Benzo(a)pyrene	2 5	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	8 6E 7
Benzo(b)fluoranthene	3 0	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 7
Diben(a h)anthracene	0 12	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	4 1E 8
Indeno(1 2 3 cd)pyrene	2 0	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	7 0E 8
Total															0 0E+0	1 2E 6	

Attachment A-16-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 6E 2	NA
Benzo(a)anthracene	2 5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 0E 6
Benzo(a)pyrene	2 5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	1 1E 5
Benzo(b)fluoranthene	3 0	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	1 2E 6
Dibenz(a h)anthracene	0 12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	5 1E 7
Indeno(1 2 3 cd)pyrene	2 0	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7 3E 01	NA	8 6E 7
Total														6 6E 2	1 4E 5

Attachment A-16-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 1E 8	5 1E 7
Ingestion	0 0014	0 0054	2 1E 8	4 3E 7
Total	0 0014	0 0054	3 2E 8	9 4E 7
Future Industrial/Commercial Worker				
Dermal	0	0	1 3E 7	1 2E 5
Ingestion	0 0051	0 010	8 6E 7	1 4E 5
Total	0 0051	0 010	9 9E 7	2 6E 5
Current Trespasser/Site Visitor				
Dermal	0	0	7 7E 9	1 0E 6
Ingestion	0 00012	0 00049	3 7E 8	7 9E 7
Total	0 00012	0 00049	4 5E 8	1 8E 6
Hypothetical Future Resident				
Dermal	0	0	1 2E 6	4 0E 5
Ingestion	0 066	0 13	1 4E 5	6 1E 5
Total	0 066	0 13	1 5E 5	1 0E 4

Attachment A 17-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Hotspot 4C Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	1 1	1 1	1/1	1 1	1 1	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	0 088	1/1	0 088	0 088	0	NE	NE	1 01

Hotspot 4C Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
Arsenic	mg/kg	1 1	1 2	2/2	1 2	1 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 088	0 1	2/2	0 1	0 094	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	0 008	0 65	2/2	0 65	0 33	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 009	0 48	2/2	0 48	0 24	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 014	0 7	2/2	0 7	0 36	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 17	0 17	1/2	0 17	0 10	0 13	NTV	7 3E+00	0 3

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-17-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.65	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	6.1E 9
Benzo(a)pyrene	0.48	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	4.5E 8
Benzo(b)fluoranthene	0.70	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	6.6E 9
Dibenz(a h)anthracene	0.17	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.6E 8
												Total	0.0E+0	7.4E 8

Attachment A-17-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.65	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	5.3E 9
Benzo(a)pyrene	0.48	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	3.9E 8
Benzo(b)fluoranthene	0.70	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	5.7E 9
Dibenz(a h)anthracene	0.17	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.4E 8
									Total	0.0E+0		6.3E 8

Attachment A-17-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.33	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.1E 10
Benzo(a)pyrene	0.24	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.6E 9
Benzo(b)fluoranthene	0.36	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.3E 10
Dibenz(a,h)anthracene	0.10	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	6.4E 10
												Total	0.0E+0	2.6E 9

Attachment A-17-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.33	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	4.0E 10
Benzo(a)pyrene	0.24	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	3.0E 9
Benzo(b)fluoranthene	0.36	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	4.4E 10
Dibenz(a h)anthracene	0.10	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.2E 9
									Total	0.0E+0		5.1E 9

Attachment A-17-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 6E 9	7 4E 8
Ingestion	0	0	5 1E 9	6 3E 8
Total	0	0	7 7E 9	1 4E 7

Attachment A-18 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 4D Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.1	5.3	3/3	5.3	4.7	0.03	NE	NE	13.22
Beryllium	mg/kg	0.92	1.4	3/3	1.4	1.1	0	2.0E-03	NTV	1.01
Chromium	mg/kg	25	31	3/3	31	28	0	3.0E-03	NTV	25.46

Hotspot 4D Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.1	6.7	6/6	5.8	5.1	0.03	NE	NE	13.22
Beryllium	mg/kg	0.92	1.9	6/6	1.6	1.3	0	5.0E-03	NTV	1.01
Chromium	mg/kg	25	48	6/6	39	32	0	2.0E-02	NTV	25.46

¹Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-18-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1.6	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	39	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-18-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 6	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	1 1E 3	NA
Chromium	39	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	6 6E 3	NA
										Total	7 6E 3	0 0E+0

Attachment A-18-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	32	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	2 7E 4	NA
Chromium	32	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 6E 3	NA
										Total	1 9E 3	0 0E+0

Attachment A-18-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	6 8E 4	NA
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA
										Total	1 1E 2	0 0E+0

Attachment A-18-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	50	250	5	70	1 825	25 550	2 0E 03	NTV	2 7E 4	NA
Chromium	28	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	4 6E 3	NA
										Total	4 8E 3	0 0E+0

Attachment A-18-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 4	1E 6	100	12	30	70	10 950	25 550	2 0E 03	NTV	3 3E 5	NA
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA
										Total	5 2E 4	0 0E+0

Attachment A-18-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-18-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	6 5E 6	NA
Chromium	28	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 1E 4	NA
										Total	1 2E 4	0 0E+0

Attachment A-18-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1.4	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	0	NA
Chromium	31	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0	NA
															Total	0.0E+0	0.0E+0

Attachment A-18-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	1 4	1E 6	200	100	350	6	24	15	70	2 190	25 550	2 0E 03	NTV	8 9E 3	NA
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA
													Total	1 4E 1	0 0E+0

Attachment A-18-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ EF \ SF_{oral} ((SA_{child} \ ED_{child} / BW_{child}) + (SA_{adult} \ ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	Hazard Index	Cancer Risk	
Beryllium	1 1	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	28	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	0 0E+0	NA
															Total	0 0E+0	0 0E+0

Attachment A-18-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	11	1E 6	100	50	350	6	3	15	70	2190	25550	2.0E 03	NTV	3.5E 3	NA	
Chromium	28	1E 6	100	50	350	6	3	15	70	2190	25550	3.0E 03	NTV	6.0E 2	NA	
														Total	6.3E 2	0.0E+0

Attachment A-18-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 4D Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 0019	0 0076	0 0E+0	0 0E+0
Total	0 0019	0 0076	0 0E+0	0 0E+0
Future Industrial/Commercial Worker				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 0048	0 011	0 0E+0	0 0E+0
Total	0 0048	0 011	0 0E+0	0 0E+0
Current Trespasser/Site Visitor				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 00012	0 00052	0 0E+0	0 0E+0
Total	0 00012	0 00052	0 0E+0	0 0E+0
Hypothetical Future Resident				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 063	0 14	0 0E+0	0 0E+0
Total	0 063	0 14	0 0E+0	0 0E+0

Attachment A 19-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 5A Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
4,4'DDE	mg/kg	65	65	1/1	65	65	0.03	5.0E-04	3.4E-01	
4,4-DDT	mg/kg	1100	1100	1/1	1100	1100	0.03	5.0E-04	3.4E-01	
Arsenic	mg/kg	8.5	8.5	1/1	8.5	8.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.82	0.82	1/1	0.82	0.82	0	NE	NE	1.01
Chromium	mg/kg	151	151	1/1	151	151	0	3.0E-03	NTV	25.46
Lead	mg/kg	1790	1790	1/1	1790	1790	0	NE	NE	363
Benzo(a)anthracene	mg/kg	25	25	1/1	25	25	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	19	19	1/1	19	19	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	16	16	1/1	16	16	0.13	NTV	7.3E-01	0.63
Benzo(k)fluoranthene	mg/kg	19	19	1/1	19	19	0.13	NTV	7.3E-02	0.46
Dibenz(a,h)anthracene	mg/kg	7.1	7.1	1/1	7.1	7.1	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	11	11	1/1	11	11	0.13	NTV	7.3E-01	0.41

Hotspot 5A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{rel} (mg/kg day) ¹	Background
4,4'DDE	mg/kg	0.1	65	2/2	65	33	0.03	5.0E-04	3.4E-01	
4,4-DDT	mg/kg	0.52	1100	2/2	1100	550	0.03	5.0E-04	3.4E-01	
Arsenic	mg/kg	4.5	8.5	2/2	8.5	8.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.75	0.82	2/2	0.82	0.79	0	NE	NE	1.01
Chromium	mg/kg	23	151	2/2	151	87	0	2.0E-02	NTV	25.46
Lead	mg/kg	20	1790	2/2	1790	905	0	NE	NE	363
Benzo(a)anthracene	mg/kg	0.026	25	2/2	25	13	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.015	19	2/2	19	9.5	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.034	16	2/2	16	8.0	0.13	NTV	7.3E-01	0.63
Benzo(k)fluoranthene	mg/kg	0.01	19	2/2	19	9.5	0.13	NTV	7.3E-02	0.46
Dibenz(a,h)anthracene	mg/kg	0.005	7.1	2/2	7.1	3.6	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3-cd)pyrene	mg/kg	0.012	11	2/2	11	5.5	0.13	NTV	7.3E-01	0.41

Present at background level *

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-19 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	0.9	0.03	3,300	60	1	70	84	25,550	5.0E 04	3.4E 01	1.2E 1	6.6E 8
4,4-DDT	1100	1E 6	0.9	0.03	3,300	60	1	70	84	25,550	5.0E 04	3.4E 01	4.5E 2	2.5E 8
Chromium	151	1E 6	0.9	0	3,300	60	1	70	84	25,550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)anthracene	25	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E 01	NA	1.5E 7
Benzo(a)pyrene	19	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E+00	NA	1.8E 6
Benzo(b)fluoranthene	16	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E 01	NA	1.5E 7
Benzo(k)fluoranthene	19	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E 02	NA	1.8E 8
Dibenz(a,h)anthracene	7.1	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E+00	NA	6.7E 7
Indeno(1,2,3-cd)pyrene	11	1E 6	0.9	0.13	3,300	60	1	70	84	25,550	NTV	7.3E 01	NA	1.0E 7
Total												1.6E 1	3.0E 6	

Attachment A-19-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _{nc}	RfD	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	4 4E 1	2 4E 7
4,4-DDT	1100	1E 6	330	60	1	70	84	25 550	5 0E 04	3 4E 01	7 4E+0	4 1E 6
Chromium	151	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	2 5E 2	NA
Benzo(a)anthracene	25	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	2 0E 7
Benzo(a)pyrene	19	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 5E 6
Benzo(b)fluoranthene	16	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 7
Benzo(k)fluoranthene	19	1E 6	330	60	1	70	84	25 550	NTV	7 3E 02	NA	1 5E 8
Dibenz(a,h)anthracene	71	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 7E 7
Indeno(1,2,3-cd)pyrene	11	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	8 9E 8
										Total	7 9E+0	6 9E 6

Attachment A-19-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	33	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	8 0E 3	2 2E 9
4,4-DDT	550	1E 6	0 2	0 03	2 000	30	1	70	42	25 550	5 0E 04	3 4E 01	1 3E 1	3 8E 8
Chromium	87	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)anthracene	13	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	8 0E 9
Benzo(a)pyrene	9 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 1E 8
Benzo(b)fluoranthene	8 0	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	5 1E 9
Benzo(k)fluoranthene	9 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 02	NA	6 1E 10
Dibenz(a,h)anthracene	3 6	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	2 3E 8
Indeno(1,2,3-cd)pyrene	5 5	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E 01	NA	3 5E 9
Total												1 4E 1	1 4E 7	

Attachment A-19-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_{fD_{oral}} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	33	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	6 6E 2	1 9E 8
4,4-DDT	550	1E 6	100	30	1	70	42	25 550	5 0E 04	3 4E 01	1 1E+0	3 1E 7
Chromium	87	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	4 4E 3	NA
Benzo(a)anthracene	13	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	9.5	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 7
Benzo(b)fluoranthene	8.0	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 8E 9
Benzo(k)fluoranthene	9.5	1E 6	100	30	1	70	42	25 550	NTV	7 3E 02	NA	1 2E 9
Dibenz(a,h)anthracene	3.6	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	4 4E 8
Indeno(1,2,3-cd)pyrene	5.5	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	6 7E 9
Total										1 2E+0	5 3E 7	

Attachment A-19-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_c \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDE	65	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	3.4E 01	2.5E 2	1.5E 6
DDT	1100	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	3.4E 01	4.3E 1	2.6E 5
Chromium	151	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	25	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	5.5E 6
Benzo(a)pyrene	19	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.2E 5
Benzo(b)fluoranthene	16	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	3.5E 6
Benzo(k)fluoranthene	19	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 02	NA	4.2E 7
Dibenz(a,h)anthracene	7.1	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.6E 5
Indeno(1,2,3 cd)pyrene	11	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.4E 6
Total												4.5E 1	9.6E 5	

Attachment A-19-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	1 3E 1	7 7E 6
4,4-DDT	1100	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	2 2E+0	1 3E 4
Chromium	151	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	4 9E 2	NA
Benzo(a)anthracene	25	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 4E 6
Benzo(a)pyrene	19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 5
Benzo(b)fluoranthene	16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	4 1E 6
Benzo(k)fluoranthene	19	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 02	NA	4 8E 7
Dibenz(a,h)anthracene	71	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 8E 5
Indeno(1,2,3-cd)pyrene	11	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	2 8E 6
										Total	2 3E+0	2 2E 4

Attachment A-19 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{or al})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{or al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT _c	RfD _{oral}	SF _{or al}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	2 3E 3	2 8E 8
4,4-DDT	1100	1E 6	0 03	0 03	2 000	250	5	70	1 825	25 550	5 0E 04	3 4E 01	3 9E 2	4 7E 7
Chromium	151	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	9 9E 8
Benzo(a)pyrene	19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	7 6E 7
Benzo(b)fluoranthene	16	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 8
Benzo(k)fluoranthene	19	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 02	NA	7 6E 9
Dibenz(a,h)anthracene	7 1	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 7
Indeno(1,2,3-cd)pyrene	11	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 4E 8
Total													4 1E 2	1 8E 6

Attachment A-19-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDE	65	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	6 4E 2	7 7E 7
DDT	1100	1E 6	50	250	5	70	1 825	25 550	5 0E 04	3 4E 01	1 1E+0	1 3E 5
Chromium	151	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	2 5E 2	NA
Benzo(a)anthracene	25	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	6 4E 7
Benzo(a)pyrene	19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	4 8E 6
Benzo(b)fluoranthene	16	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	4 1E 7
Benzo(k)fluoranthene	19	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 02	NA	4 8E 8
Dibenz(a,h)anthracene	7 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 8E 6
Indeno(1 2 3 cd)pyrene	11	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	2 8E 7
Total											1 2E+0	2 2E 5

Attachment A-19 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDE	65	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 8E 3	1 3E 7
DDT	1100	1E 6	0 3	0 03	3 300	12	30	70	10 950	25 550	5 0E 04	3 4E 01	3 1E 2	2 2E 6
Chromium	151	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	4 7E 7
Benzo(a)pyrene	19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 6E 6
Benzo(b)fluoranthene	16	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 0E 7
Benzo(k)fluoranthene	19	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 02	NA	3 6E 8
Dibenz(a h)anthracene	7 1	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 3E 6
Indeno(1 2 3 cd)pyrene	11	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 1E 7
												Total	3 3E 2	8 3E 6

Attachment A-19-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25-550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	6 1E 3	4 4E 7
4,4-DDT	1100	1E 6	100	12	30	70	10 950	25 550	5 0E 04	3 4E 01	1 0E 1	7 5E 6
Chromium	151	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	2 4E 3	NA
Benzo(a)anthracene	25	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	3 7E 7
Benzo(a)pyrene	19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	2 8E 6
Benzo(b)fluoranthene	16	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	2 4E 7
Benzo(k)fluoranthene	19	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 02	NA	2 8E 8
Dibenz(a,h)anthracene	7.1	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	1 0E 6
Indeno(1,2,3-cd)pyrene	11	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E 01	NA	1 6E 7
Total										1 1E 1	1 3E 5	

Attachment A-19-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{o,i})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
DDE	65	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	7 3E 5	1 6E 9
DDT	1100	1E 6	0 04	0 03	2 000	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 2E 3	2 7E 8
Chromium	151	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	25	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	5 7E 9
Benzo(a)pyrene	19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	4 4E 8
Benzo(b)fluoranthene	16	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 7E 9
Benzo(k)fluoranthene	19	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 02	NA	4 4E 10
Dibenz(a,h)anthracene	7 1	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	1 6E 8
Indeno(1,2,3 cd)pyrene	11	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 5E 9
Total												1 3E 3	1 0E 7	

Attachment A-19-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4 4 DDE	65	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	1 5E 3	3 3E 8
4 4 DDT	1100	1E 6	50	6	9	70	3 285	25 550	5 0E 04	3 4E 01	2 6E 2	5 6E 7
Chromium	151	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	5 9E 4	NA
Benzo(a)anthracene	25	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 8E 8
Benzo(a)pyrene	19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 1E 7
Benzo(b)fluoranthene	16	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 8E 8
Benzo(k)fluoranthene	19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	2 1E 9
Dibenz(a h)anthracene	7 1	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 8E 8
Indeno(1 2 3 cd)pyrene	11	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 2E 8
											Total	2 8E 2
												9 5E 7

Attachment A 19 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF) / ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult})) / (AT)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	0.3	0.03	1 913	3 300	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	0 1430819	5.2E 6
4,4-DDT	1100	1E 6	0.3	0.03	1 913	3 300	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	2 4213863	8.7E 5
Chromium	151	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0	NA
Benzo(a)anthracene	25	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.8E 5
Benzo(a)pyrene	19	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.4E 4
Benzo(b)fluoranthene	16	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.2E 5
Benzo(k)fluoranthene	19	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 02	NA	1.4E 6
Dibenz(a,h)anthracene	71	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	5.3E 5
Indeno(1,2,3-cd)pyrene	11	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	8.1E 6
Total															2.6E+0	3.3E 4	

Attachment A 19 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT \cdot RfD_{ref})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{ref} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{ref}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
DDE	65	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	1 7E+0	3 5E 5
DDT	1100	1E 6	200	100	350	6	24	15	70	2 190	25 550	5 0E-04	3 4E 01	2 8E+1	5 9E 4
Chromium	151	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E-03	NTV	6 4E 1	NA
Benzo(a)anthracene	25	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 01	NA	2 9E 5
Benzo(a)pyrene	19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	2 2E 4
Benzo(b)fluoranthene	16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 8E 5
Benzo(k)fluoranthene	19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E 02	NA	2 2E 6
Dibenz(a,h)anthracene	7 1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	8 1E 5
Indeno(1,2,3-cd)pyrene	11	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7 3E-01	NA	1 3E 5
Total														3 0E+1	9 8E 4

Attachment A 19 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non-Carcinogens (days)
RfD = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4-DDE	65	1E 6	0.04	0.03	1,440	2,000	350	6	3	15	70	2,190	25,550	5.0E 04	3.4E 01	1.4E 2	2.4E 7
4,4-DDT	1100	1E 6	0.04	0.03	1,440	2,000	350	6	3	15	70	2,190	25,550	5.0E 04	3.4E 01	2.4E 1	4.1E 6
Chromium	151	1E 6	0.04	0	1,440	2,000	350	6	3	15	70	2,190	25,550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	25	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E 01	NA	8.6E 7
Benzo(a)pyrene	19	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E+00	NA	6.5E 6
Benzo(b)fluoranthene	16	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E 01	NA	5.5E 7
Benzo(k)fluoranthene	19	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E 02	NA	6.5E 8
Dibenz(a,h)anthracene	7.1	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E+00	NA	2.4E 6
Indeno(1,2,3-cd)pyrene	11	1E 6	0.04	0.13	1,440	2,000	350	6	3	15	70	2,190	25,550	NTV	7.3E 01	NA	3.8E 7
Total																2.6E 1	1.5E 5

Attachment A 19-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{ref})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{ref} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_{carc})$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT_{carc} = Averaging Time for Carcinogens (25 550 days)
SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
4,4 DDE	65	1E 6	100	50	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	8.3E 1	1.3E 5
4,4 DDT	1100	1E 6	100	50	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	1.4E+1	2.2E 4
Chromium	151	1E 6	100	50	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	3.2E 1	NA
Benzo(a)anthracene	25	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E 5
Benzo(a)pyrene	19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	8.0E 5
Benzo(b)fluoranthene	16	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	6.7E 6
Benzo(k)fluoranthene	19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 02	NA	8.0E 7
Dibenz(a,h)anthracene	71	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.0E 5
Indeno(1,2,3-cd)pyrene	11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	4.6E 6
												Total	1.5E+1		3.6E 4

Attachment A-19-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 5A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 14	0 16	1 4E 7	3 0E 6
Ingestion	1 2	7 9	5 3E 7	6 9E 6
Total	<u>1 3</u>	<u>8 0</u>	<u>6 7E 7</u>	<u>9 9E 6</u>
Future Industrial/Commercial Worker				
Dermal	0 041	0 45	1 8E 6	9 6E 5
Ingestion	1 2	2 3	2 2E 5	2 2E 4
Total	<u>1 2</u>	<u>2 8</u>	<u>2 4E 5</u>	<u>3 2E 4</u>
Current Trespasser/Site Visitor				
Dermal	0 0013	0 033	1 0E 7	8 3E 6
Ingestion	0 028	0 11	9 5E 7	1 3E 5
Total	<u>0 029</u>	<u>0 14</u>	<u>1 0E 6</u>	<u>2 1E 5</u>
Hypothetical Future Resident				
Dermal	0 26	2 6	1 5E 5	3 3E 4
Ingestion	1 5	30	3 6E 4	9 8E 4
Total	<u>1 5</u>	<u>33</u>	<u>3 8E 4</u>	<u>1 3E 3</u>

Attachment A 20 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 5B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Benzo(a)pyrene	mg/kg	0.3	0.3	1/1	0.30	0.30	0.13	NTV	7.3E+00	0.74

Hotspot 5B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Benzo(a)anthracene	mg/kg	0.035	1.6	3/3	1.6	0.67	0.13	NTV	7.3E 01	0.89
Benzo(a)pyrene	mg/kg	0.024	1.3	3/3	1.3	0.54	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.028	1.7	3/3	1.7	0.70	0.13	NTV	7.3E 01	0.63
Dibenz(a h)anthracene	mg/kg	0.004	0.2	3/3	0.20	0.087	0.13	NTV	7.3E+00	0.3
Indeno(1 2 3 cd)pyrene	mg/kg	0.013	0.8	3/3	0.80	0.33	0.13	NTV	7.3E 01	0.41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-20-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_c \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.6	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.5E 8
Benzo(a)pyrene	1.3	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.2E 7
Benzo(b)fluoranthene	1.7	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.6E 8
Dibenz(a h)anthracene	0.20	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.9E 8
Indeno(1 2 3 cd)pyrene	0.80	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	7.6E 9
												Total	0.0E+0	1.8E 7

Attachment A-20-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.6	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.3E 8
Benzo(a)pyrene	1.3	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.1E 7
Benzo(b)fluoranthene	1.7	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.4E 8
Dibenz(a h)anthracene	0.20	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.6E 8
Indeno(1 2 3 cd)pyrene	0.80	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	6.5E 9
										Total	0.0E+0	1.5E 7

Attachment A-20-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.67	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	4.3E 10
Benzo(a)pyrene	0.54	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.4E 9
Benzo(b)fluoranthene	0.70	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	4.5E 10
Dibenz(a h)anthracene	0.087	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	5.6E 10
Indeno(1 2 3 cd)pyrene	0.33	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.1E 10
												Total	0.0E+0	5.1E 9

Attachment A-20-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.67	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	8.2E 10
Benzo(a)pyrene	0.54	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	6.6E 9
Benzo(b)fluoranthene	0.70	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	8.6E 10
Dibenz(a h)anthracene	0.087	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.1E 9
Indeno(1 2 3 cd)pyrene	0.33	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	4.1E 10
										Total	0.0E+0	9.8E 9

Attachment A-20-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{nc} \text{ RfD}_{oral})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{oral}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	6.6E 7
												Total	0.0E+0	6.6E 7

Attachment A-20-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E 6	100	250	25	70	9.125	25.550	NTV	7.3E+00	NA	7.7E-7
										Total	0.0E+0	7.7E-7

Attachment A-20-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E 6	0.03	0.13	2.000	250	5	70	1.825	25.550	NTV	7.3E+00	NA	1.2E 8
												Total	0.0E+0	1.2E 8

Attachment A-20-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	50	250	5	70	1.825	25.550	NTV	7.3E+00	NA	7.7E-8	
											Total	0.0E+0	7.7E-8

Attachment A-20-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	5.7E-8	
													Total	0.0E+0	5.7E-8

Attachment A-20-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	4.4E-8
										Total	0.0E+0	4.4E-8

Attachment A-20-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	6.9E-10	
													Total	0.0E+0	6.9E-10

Attachment A-20-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	50	6	9	70	3.285	25.550	NTV	7.3E+00	NA	3.3E 9	
											Total	0.0E+0	3.3E 9

Attachment A-20-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad lt} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad lt} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{o al} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{ad lt} \cdot ED_{ad lt} / BW_{ad lt}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad lt}	EF	ED _{child}	ED _{ad lt}	BW _{child}	BW _{ad lt}	AT _c	AT	RfD ₁	SF _{o al}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E-6	0.3	0.13	1913	3300	350	6	24	15	70	2190	25550	NTV	7.3E+00	NA	2.2E-6
															Total	0.0E+0	2.2E-6

Attachment A-20-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	3.4E 6	
														Total	0.0E+0	3.4E 6

Attachment A-20-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.30	1E 6	0.04	0.13	1.440	2.000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	1.0E-7
															Total	0.0E+0	1.0E-7

Attachment A-20-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} \ ((IR_{child} \ ED_{child} / BW_{child}) + (IR_{adult} \ ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.30	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.3E 6
													Total	0.0E+0	1.3E 6

Attachment A-20-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 5B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	5 1E 9	1 8E 7
Ingestion	0	0	9 8E 9	1 5E 7
Total	<hr/> 0	<hr/> 0	<hr/> 1 5E 8	<hr/> 3 3E 7
Future Industrial/Commercial Worker				
Dermal	0	0	1 2E 8	6 6E 7
Ingestion	0	0	7 7E 8	7 7E 7
Total	<hr/> 0	<hr/> 0	<hr/> 8 8E 8	<hr/> 1 4E 6
Current Trespasser/Site Visitor				
Dermal	0	0	6 9E 10	5 7E 8
Ingestion	0	0	3 3E 9	4 4E 8
Total	<hr/> 0	<hr/> 0	<hr/> 4 0E 9	<hr/> 1 0E 7
Hypothetical Future Resident				
Dermal	0	0	1 0E 7	2 2E 6
Ingestion	0	0	1 3E 6	3 4E 6
Total	<hr/> 0	<hr/> 0	<hr/> 1 4E 6	<hr/> 5 6E 6

Attachment A 21 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 6 Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
4,4'-DDT	mg/kg	0.0062	4	6/7	0.91	0.38	0.03	5.0E-04	3.4E-01	
Arsenic	mg/kg	4	57	7/7	4.9	4.5	0.03	NE	NE	13.22
Beryllium	mg/kg	0.76	16	7/7	1.2	0.97	0	2.0E-03	NTV	1.01
Mercury	mg/kg	0.015	15	6/7	0.94	0.52	0	3.0E-04	NTV	0.15

Hotspot 6 Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
4,4'-DDT	mg/kg	0.0014	21	12/14	1.8	0.75	0.03	5.0E-04	3.4E-01	
Arsenic	mg/kg	31	57	14/14	4.8	4.4	0.03	NE	NE	13.22
Beryllium	mg/kg	0.76	16	14/14	1.2	1.0	0	5.0E-03	NTV	1.01
Chromium	mg/kg	18	31	14/14	26	24	0	2.0E-02	NTV	25.46
Mercury	mg/kg	0.011	15	12/15	0.63	0.32	0	3.0E-03	NTV	0.15

¹Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-21-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
4,4'-DDT	1.8	1E 6	0.9	0.03	3 300	60	1	70	84	25 550	5.0E 04	3.4E 01	3.3E 3	1.8E 9	
Beryllium	1.2	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA	
Chromium	26	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA	
Mercury	0.63	1E 6	0.9	0	3 300	60	1	70	84	25 550	3.0E 03	NTV	0.0E+0	NA	
													Total	3.3E 3	1.8E 9

Attachment A-21-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	1.8	1E 6	330	60	1	70	84	25 550	5.0E 04	3.4E 01	1.2E 2	6.8E 9
Beryllium	1.2	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	8.1E 4	NA
Chromium	26	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	4.4E 3	NA
Mercury	0.63	1E 6	330	60	1	70	84	25 550	3.0E 03	NTV	7.1E 4	NA
										Total	1.8E 2	6.8E 9

Attachment A-21-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.75	1E 6	0.2	0.03	2 000	30	1	70	42	25 550	5.0E 04	3.4E 01	1.8E 4	5.1E 11
Beryllium	1.0	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	24	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Mercury	0.32	1E 6	0.2	0	2 000	30	1	70	42	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	1.8E 4	5.1E 11

Attachment A-21-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.75	1E 6	100	30	1	70	42	25 550	5.0E 04	3.4E 01	1.5E 3	4.3E 10
Beryllium	1.0	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	2.0E 4	NA
Chromium	24	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.2E 3	NA
Mercury	0.32	1E 6	100	30	1	70	42	25 550	3.0E 03	NTV	1.1E 4	NA
										Total	3.1E 3	4.3E 10

Attachment A-21-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
4,4 DDT	0.91	1E 6	0.20	0.03	3 300	250	25	70	9 125	25 550	5.0E 04	0.34	3.5E 4	2.1E 8	
Beryllium	1.2	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	2.0E 03	NTV	0.0E+0	NA	
Mercury	0.94	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 04	NTV	0.0E+0	NA	
													Total	3.5E 4	2.1E 8

Attachment A-21-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.91	1E 6	100	250	25	70	9 125	25 550	5.0E 04	0.34	1.8E 3	1.1E 7
Beryllium	1.2	1E 6	100	250	25	70	9 125	25 550	2.0E 03	NTV	5.9E 4	NA
Mercury	0.94	1E 6	100	250	25	70	9 125	25 550	3.0E 04	NTV	3.1E 3	NA
										Total	5.4E 3	1.1E 7

Attachment A-21-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.38	1E 6	0.03	0.03	2 000	250	5	70	1 825	25 550	5.0E-04	0.34	1.3E-5	1.6E-10
Beryllium	0.97	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	2.0E-03	NTV	0.0E+0	NA
Mercury	0.52	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E-04	NTV	0.0E+0	NA
												Total	1.3E-5	1.6E-10

Attachment A-21-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4 DDT	0.38	1E 6	50	250	5	70	1 825	25 550	5.0E 04	0.34	3.7E 4	4.5E 9
Beryllium	0.97	1E 6	50	250	5	70	1 825	25 550	2.0E 03	NTV	2.4E 4	NA
Mercury	0.52	1E 6	50	250	5	70	1 825	25 550	3.0E 04	NTV	8.5E 4	NA
										Total	1.5E 3	4.5E 9

Attachment A-21-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
44 DDT	0.91	1E 6	0.3	0.03	3 300	12	30	70	10 950	25 550	5.0E-04	0.34	2.5E-5	1.8E-9
Beryllium	1.2	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	2.0E-03	NTV	0.0E+0	NA
Mercury	0.94	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E-04	NTV	0.0E+0	NA
												Total	2.5E-5	1.8E-9

Attachment A-21-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
44 DDT	0.91	1E 6	100	12	30	70	10 950	25 550	5.0E 04	0.34	8.5E 5	6.2E 9
Beryllium	1.2	1E 6	100	12	30	70	10 950	25 550	2.0E 03	NTV	2.8E 5	NA
Mercury	0.94	1E 6	100	12	30	70	10 950	25 550	3.0E 04	NTV	1.5E 4	NA
										Total	2.6E 4	6.2E 9

Attachment A-21-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
44 DDT	0.38	1E 6	0.04	0.03	2 000	6	9	70	3 285	25 550	5.0E 04	0.34	4.3E 7	9.4E 12
Beryllium	0.97	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	2.0E 03	NTV	0.0E+0	NA
Mercury	0.52	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3.0E 04	NTV	0.0E+0	NA
												Total	4.3E 7	9.4E 12

Attachment A-21-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.38	1E 6	50	6	9	70	3 285	25 550	5.0E 04	0.34	8.9E 6	2.0E 10
Beryllium	0.97	1E 6	50	6	9	70	3 285	25 550	2.0E 03	NTV	5.7E 6	NA
Mercury	0.52	1E 6	50	6	9	70	3 285	25 550	3.0E 04	NTV	2.0E 5	NA
										Total	3.5E 5	2.0E 10

Attachment A-21-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
4,4'-DDT	0.91	1E 6	0.3	0.03	1 913	3 300	350	6	24	15	70	2 190	25 550	5.0E 04	0.34	0.00200315	7.2E 8	
Beryllium	1.2	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	0	NA	
Mercury	0.94	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 04	NTV	0	NA	
																Total	2.0E 3	7.2E 8

Attachment A-21-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT _c	RfD	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.91	1E 6	200	100	350	6	24	15	70	2 190	25 550	5.0E 04	0.34	2.3E 2	4.8E 7
Beryllium	1.2	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	7.7E 3	NA
Mercury	0.94	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 04	NTV	4.0E 2	NA
													Total	7.1E 2	4.8E 7

Attachment A-21 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
4,4'-DDT	0.38	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E 04	0.34	8.4E 5	1.4E 9
Beryllium	0.97	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	0.0E+0	NA
Mercury	0.52	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E 04	NTV	0.0E+0	NA
															Total	8.4E 5	1.4E 9

Attachment A-21-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} \ ((IR_{child} \ ED_{child} / BW_{child}) + (IR_{adult} \ ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
4,4 DDT	0.38	1E 6	100	50	350	6	3	15	70	2190	25 550	5.0E 04	0.34	4.9E 3	7.5E 8	
Beryllium	0.97	1E 6	100	50	350	6	3	15	70	2190	25 550	2.0E 03	NTV	3.1E 3	NA	
Mercury	0.52	1E 6	100	50	350	6	3	15	70	2190	25 550	3.0E 04	NTV	1.1E 2	NA	
														Total	1.9E 2	7.5E 8

Attachment A-21-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 6 Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 00018	0 0033	5 1E 11	1 8E 9
Ingestion	0 0031	0 018	4 3E 10	6 8E 9
Total	<u>0 0033</u>	<u>0 021</u>	<u>4 8E 10</u>	<u>8 6E 9</u>
Future Industrial/Commercial Worker				
Dermal	0 000013	0 00035	1 6E 10	2 1E 8
Ingestion	0 0015	0 0054	4 5E 9	1 1E 7
Total	<u>0 0015</u>	<u>0 0058</u>	<u>4 7E 9</u>	<u>1 3E 7</u>
Current Trespasser/Site Visitor				
Dermal	0 00000043	0 000025	9 4E 12	1 8E 9
Ingestion	0 000035	0 00026	2 0E 10	6 2E 9
Total	<u>0 000035</u>	<u>0 00029</u>	<u>2 0E 10</u>	<u>8 1E 9</u>
Hypothetical Future Resident				
Dermal	0 000084	0 0020	1 4E 9	7 2E 8
Ingestion	0 019	0 071	7 5E 8	4 8E 7
Total	<u>0 019</u>	<u>0 073</u>	<u>7 6E 8</u>	<u>5 6E 7</u>

Attachment A-22-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7A Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
PCB 1254	mg/kg	0.016	0.34	6/8	0.14	0.08	0.14	2.0E-05	2/1 ^a	
Arsenic	mg/kg	5.2	7.3	7/7	6.5	5.9	0.03	NE	NE	13.22
Beryllium	mg/kg	0.5	0.66	7/7	0.62	0.59	0	NE	NE	1.01 ^b
Chromium	mg/kg	24	42	7/7	38	32	0	3.0E-03	NTV	25.46
Benzo(a)anthracene	mg/kg	0.48	3.8	7/7	3.4	1.3	0.13	NTV	7.3E 01	0.89
Benzo(a)pyrene	mg/kg	0.56	2.8	7/7	2.2	1.1	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.7	4	7/7	3.1	1.5	0.13	NTV	7.3E 01	0.63
Dibenz(a,h)anthracene	mg/kg	0.075	0.25	7/7	0.19	0.12	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	0.29	1.7	7/7	1.4	0.66	0.13	NTV	7.3E 01	0.41

Hotspot 7A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
PCB 1254	mg/kg	0.016	0.34	6/22	0.13	0.095	0.14	5.0E-05	2/1 ^a	
Arsenic	mg/kg	1.1	7.3	21/21	4.8	4.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.5	0.89	21/21	0.7	0.68	0	NE	NE	1.01 ^b
Chromium	mg/kg	22	42	21/21	32	30	0	2.0E 02	NTV	25.46
Benzo(a)anthracene	mg/kg	0.002	3.8	19/21	1.6	0.76	0.13	NTV	7.3E 01	0.89
Benzo(a)pyrene	mg/kg	0.003	2.8	19/21	1.1	0.51	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.005	4	19/21	1.4	0.71	0.13	NTV	7.3E 01	0.63
Dibenz(a,h)anthracene	mg/kg	0.004	0.25	12/21	0.087	0.061	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	0.001	1.7	18/21	0.91	0.46	0.13	NTV	7.3E 01	0.41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

IRIS recommends using a slope factor of 2.0 for RME and 1.0 for CTE

Attachment A-22-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.13	1E-6	0.9	0.14	3.300	60	1	70	84	25.550	5.0E-05	2.0E+00	1.1E-2	3.6E-9
Chromium	32	1E-6	0.9	0	3.300	60	1	70	84	25.550	2.0E-02	NTV	0.0E+0	NA
Benzo(a)anthracene	1.6	1E-6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E-01	NA	1.5E-8
Benzo(a)pyrene	1.1	1E-6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E+00	NA	1.0E-7
Benzo(b)fluoranthene	1.4	1E-6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E-01	NA	1.3E-8
Dibenz(a,h)anthracene	0.087	1E-6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E+00	NA	8.2E-9
Indeno(1,2,3 cd)pyrene	0.91	1E-6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E-01	NA	8.6E-9
Total												1.1E-2	1.5E-7	

Attachment A-22-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_c \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.13	1E 6	330	60	1	70	84	25 550	5.0E-05	2.0E+00	8.8E-3	2.9E-9
Chromium	32	1E 6	330	60	1	70	84	25 550	2.0E-02	NTV	5.4E-3	NA
Benzo(a)anthracene	1.6	1E 6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	1.3E-8
Benzo(a)pyrene	1.1	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	8.9E-8
Benzo(b)fluoranthene	1.4	1E 6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	1.1E-8
Dibenz(a,h)anthracene	0.087	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	7.0E-9
Indeno(1,2,3 cd)pyrene	0.91	1E 6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	7.4E-9
										Total	1.4E-2	1.3E-7

Attachment A-22-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm^2)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm^2/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _{nc}	RfD _{oral}	SF	Hazard Index	Cancer Risk
PCB 1254	0.095	1E 6	0 2	0 14	2 000	30	1	70	42	25 550	5.0E-05	1.0E+00	1.1E 3	8.9E 11
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2.0E-02	NTV	0.0E+0	NA
Benzo(a)anthracene	0.76	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7.3E-01	NA	4.8E 10
Benzo(a)pyrene	0.51	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.2E 9
Benzo(b)fluoranthene	0.71	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7.3E-01	NA	4.5E 10
Dibenz(a h)anthracene	0.061	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.9E 10
Indeno(1 2 3 cd)pyrene	0.46	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7.3E-01	NA	2.9E 10
Total													1.1E 3	5.0E 9

Attachment A-22-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
PCB 1254	0 095	1E 6	100	30	1	70	42	25 550	5 0E 05	1 0E+00	1 9E 3	1 6E 10
Chromium	30	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
Benzo(a)anthracene	0 76	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	9 3E 10
Benzo(a)pyrene	0 51	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	6 2E 9
Benzo(b)fluoranthene	0 71	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	8 7E 10
Dibenz(a h)anthracene	0 061	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	7 5E 10
Indeno(1 2 3 cd)pyrene	0 46	1E 6	100	30	1	70	42	25 550	NTV	7 3E 01	NA	5 6E 10
										Total	3 5E 3	9 5E 9

Attachment A-22-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_c \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E 6	0.20	0.14	3.300	250	25	70	9.125	25.550	2.0E 05	2.0E+00	6.3E 3	9.0E 8
Chromium	38	1E 6	0.20	0	3.300	250	25	70	9.125	25.550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	3.4	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E 01	NA	7.4E 7
Benzo(a)pyrene	2.2	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E+00	NA	4.8E 6
Benzo(b)fluoranthene	3.1	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E 01	NA	6.8E 7
Dibenz(a,h)anthracene	0.19	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E+00	NA	4.2E 7
Indeno(1,2,3 cd)pyrene	1.4	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E 01	NA	3.1E 7
Total													6.3E 3	7.1E 6

Attachment A-22-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E 6	100	250	25	70	9 125	25 550	2.0E-05	2.0E+00	6.8E-3	9.8E-8
Chromium	38	1E 6	100	250	25	70	9 125	25 550	3.0E-03	NTV	1.2E-2	NA
Benzo(a)anthracene	3.4	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E-01	NA	8.7E-7
Benzo(a)pyrene	2.2	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	5.6E-6
Benzo(b)fluoranthene	3.1	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E-01	NA	7.9E-7
Dibenz(a h)anthracene	0.19	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.8E-7
Indeno(1 2 3 cd)pyrene	1.4	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E-01	NA	3.6E-7
Total										1.9E-2	8.2E-6	

Attachment A-22-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.080	1E 6	0.03	0.14	2 000	250	5	70	1 825	25 550	2.0E 05	1.0E+00	3.3E 4	4.7E 10
Chromium	32	1E 6	0.03	0	2 000	250	5	70	1 825	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.3	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	5.2E 9
Benzo(a)pyrene	1.1	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.4E 8
Benzo(b)fluoranthene	1.5	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	6.0E 9
Dibenz(a,h)anthracene	0.12	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.8E 9
Indeno(1 2 3 cd)pyrene	0.66	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	2.6E 9
												Total	3.3E 4	6.3E 8

Attachment A-22-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0 080	1E 6	50	250	5	70	1 825	25 550	2 0E 05	1 0E+00	2 0E 3	2 8E 9
Chromium	32	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 2E 3	NA
Benzo(a)anthracene	1 3	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 3E 8
Benzo(a)pyrene	1 1	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	2 8E 7
Benzo(b)fluoranthene	1 5	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	3 8E 8
Dibenz(a h)anthracene	0 12	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 1E 8
Indeno(1 2 3 cd)pyrene	0 66	1E 6	50	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 7E 8
										Total	7 2E 3	4 0E 7

Attachment A-22-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-8} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E 6	0.3	0.14	3 300	12	30	70	10 950	25 550	2.0E 05	2.0E+00	4.6E 4	7.8E 9
Chromium	38	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)anthracene	3.4	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	6.4E 8
Benzo(a)pyrene	2.2	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	4.2E 7
Benzo(b)fluoranthene	3.1	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	5.9E 8
Dibenz(a h)anthracene	0.19	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.6E 8
Indeno(1 2 3 cd)pyrene	1.4	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	2.6E 8
Total													4.6E 4	6.1E 7

Attachment A-22-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E 6	100	12	30	70	10 950	25 550	2.0E 05	2.0E+00	3.3E 4	5.6E 9
Chromium	38	1E 6	100	12	30	70	10 950	25 550	3.0E 03	NTV	5.9E 4	NA
Benzo(a)anthracene	3.4	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	5.0E 8
Benzo(a)pyrene	2.2	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.2E 7
Benzo(b)fluoranthene	3.1	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	4.6E 8
Dibenz(a h)anthracene	0.19	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.8E 8
Indeno(1 2 3 cd)pyrene	1.4	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	2.1E 8
Total										9.2E 4	4.7E 7	

Attachment A-22-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm^3)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm^2/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _c	AT _c	RfD _o	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.080	1E 6	0.04	0.14	2 000	6	9	70	3 285	25 550	2 0E 05	1 0E+00	1 1E 5	2 7E 11
Chromium	32	1E 6	0.04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)anthracene	1.3	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 0E 10
Benzo(a)pyrene	1.1	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 5E 9
Benzo(b)fluoranthene	1.5	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	3 4E 10
Dibenz(a,h)anthracene	0.12	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 8E 10
Indeno(1 2 3 cd)pyrene	0.66	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E 01	NA	1 5E 10
												Total	1 1E 5	3 6E 9

Attachment A-22-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.080	1E 6	50	6	9	70	3 285	25 550	2.0E 05	1.0E+00	4.7E 5	1.2E 10
Chromium	32	1E 6	50	6	9	70	3 285	25 550	3.0E 03	NTV	1.3E 4	NA
Benzo(a)anthracene	1.3	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.4E 9
Benzo(a)pyrene	1.1	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.2E 8
Benzo(b)fluoranthene	1.5	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.7E 9
Dibenz(a h)anthracene	0.12	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	1.3E 9
Indeno(1 2 3 cd)pyrene	0.66	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	7.3E 10
Total										1.7E 4	1.7E 8	

Attachment A 22 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{rel} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E-6	0.3	0.14	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E-05	2.0E+00	0.03595392	3.1E-7
Chromium	38	1E-6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E-03	NTV	0	NA
Benzo(a)anthracene	3.4	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E-01	NA	2.5E-6
Benzo(a)pyrene	2.2	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	1.6E-5
Benzo(b)fluoranthene	3.1	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E-01	NA	2.3E-6
Dibenz(a,h)anthracene	0.19	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	1.4E-6
Indeno(1,2,3 cd)pyrene	1.4	1E-6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E-01	NA	1.0E-6
Total																3.6E-2	2.4E-5

Attachment A 22 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.14	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E-05	2.0E+00	8.9E 2	4.4E 7
Chromium	38	1E-6	200	100	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	1.6E 1	NA
Benzo(a)anthracene	3.4	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.9E 6
Benzo(a)pyrene	2.2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.5E 5
Benzo(b)fluoranthene	3.1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	3.5E 6
Dibenz(a,h)anthracene	0.19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.2E 6
Indeno(1,2,3 cd)pyrene	1.4	1E-6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.6E-6
Total														2.5E 1	3.7E 5

Attachment A 22 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF) / ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult})) / (AT_{carc})$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_{carc} = Averaging Time for Carcinogens (days)
SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
PCB 1254	0.080	1E-6	0.04	0.14	1.440	2.000	350	6	3	15	70	2.190	25.550	2.0E-05	1.0E+00	2.1E-3	4.1E-9
Chromium	32	1E-6	0.04	0	1.440	2.000	350	6	3	15	70	2.190	25.550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)anthracene	1.3	1E-6	0.04	0.13	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	7.3E-01	NA	4.5E-8
Benzo(a)pyrene	1.1	1E-6	0.04	0.13	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	7.3E+00	NA	3.8E-7
Benzo(b)fluoranthene	1.5	1E-6	0.04	0.13	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	7.3E-01	NA	5.2E-8
Dibenz(a,h)anthracene	0.12	1E-6	0.04	0.13	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	7.3E+00	NA	4.1E-8
Indeno(1,2,3-cd)pyrene	0.66	1E-6	0.04	0.13	1.440	2.000	350	6	3	15	70	2.190	25.550	NTV	7.3E-01	NA	2.3E-8
Total																2.1E-3	5.4E-7

Attachment A 22-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
PCB 1254	0.080	1E 6	100	50	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	2.6E 2	4.6E 8
Chromium	32	1E-6	100	50	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	6.8E 2	NA
Benzo(a)anthracene	1.3	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	5.5E 7
Benzo(a)pyrene	1.1	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	4.6E 6
Benzo(b)fluoranthene	1.5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	6.3E 7
Dibenz(a,h)anthracene	0.12	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	5.1E 7
Indeno(1,2,3-cd)pyrene	0.66	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	2.8E 7
Total														9.4E 2	6.6E 6

Attachment A-22-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 0011	0 011	5 0E 9	1 5E 7
Ingestion	0 0035	0 014	9 5E 9	1 3E 7
Total	<u>0 0046</u>	<u>0 025</u>	<u>1 4E 8</u>	<u>2 8E 7</u>
Future Industrial/Commercial Worker				
Dermal	0 00033	0 0063	6 3E 8	7 1E 6
Ingestion	0 0072	0 019	4 0E 7	8 2E 6
Total	<u>0 0075</u>	<u>0 026</u>	<u>4 7E 7</u>	<u>1 5E 5</u>
Current Trespasser/Site Visitor				
Dermal	0 000011	0 00046	3 6E 9	6 1E 7
Ingestion	0 00017	0 0009	1 7E 8	4 7E 7
Total	<u>0 00018</u>	<u>0 0014</u>	<u>2 1E 8</u>	<u>1 1E 6</u>
Hypothetical Future Resident				
Dermal	0 0021	0 036	5 4E 7	2 4E 5
Ingestion	0 094	0 25	6 6E 6	3 7E 5
Total	<u>0 10</u>	<u>0 29</u>	<u>7 2E 6</u>	<u>6 1E 5</u>

Attachment A 23 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7B Surface Soil (0-0 5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	3 2	3 2	1/1	3 2	3 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 38	0 38	1/1	0 38	0 38	0	NE	NE	1 01
Benzo(a)pyrene	mg/kg	0 072	0 072	1/1	0 072	0 072	0 13	NTV	7 3	0 74

Hotspot 7B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	3 2	5 6	3/3	5 6	4 3	0 03	NE	NE	13 22
Beryllium	mg/kg	0 38	1 3	3/3	1 3	0 74	0	5 0E 03	NTV	1 01
Benzo(a)pyrene	mg/kg	0 033	0 072	2/3	0 072	0 045	0 13	NTV	7 3	0 74

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-23-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	1 3	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 072	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	6 8E 9	
													Total	0 0E+0	6 8E 9

Attachment A-23-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	8 8E 4	NA
Benzo(a)pyrene	0 072	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	5 8E 9
										Total	8 8E 4	5 8E 9

Attachment A-23-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	0.74	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA	
Benzo(a)pyrene	0.045	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.9E 10	
													Total	0.0E+0	2.9E 10

Attachment A-23-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.74	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.5E 4	NA
Benzo(a)pyrene	0.045	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	5.6E 10
										Total	1.5E 4	5.6E 10

Attachment A-23-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)¹

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E+00	NA	1.6E 7
												Total	0.0E+0	1.6E 7

Attachment A-23-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	1.8E-7
										Total	0.0E+0	1.8E-7

Attachment A-23-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)¹

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.9E 9
												Total	0.0E+0	2.9E 9

Attachment A-23-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{nc} \text{ RfD}_{oral})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{oral}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	50	250	5	70	1.825	25.550	NTV	7.3E+00	NA	1.8E 8
											Total	0.0E+0

Attachment A-23-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.4E 8
												Total	0.0E+0	1.4E 8

Attachment A-23-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	1.1E-8
											Total	0.0E+0

Attachment A-23-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	1.7E-10
													Total	0.0E+0

Attachment A-23-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	7.9E-10
										Total	0.0E+0	7.9E-10

Attachment A-23-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad lt} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad lt} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad lt} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{ad lt} \cdot ED_{ad lt} / BW_{ad lt}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad lt}	EF	ED _{child}	ED _{ad lt}	BW _{child}	BW _{ad lt}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2190	25550	NTV	7.3E+00	NA	5.3E-7
															Total	0.0E+0	5.3E-7

Attachment A-23-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day) ¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.072	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	8.2E-7	
														Total	0.0E+0	8.2E-7

Attachment A-23-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	0.04	0.13	1440	2000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	2.5E-8
															Total	0.0E+0	2.5E-8

Attachment A-23-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR_{child}	IR_{adult}	EF	ED_{child}	ED_{adult}	BW_{child}	BW_{adult}	AT	AT_c	RfD_{oral}	SF_{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.072	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.0E 7
														Total	0.0E+0

Attachment A-23-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 9E 10	6 8E 9
Ingestion	0 00015	0 00088	5 6E 10	5 8E 9
Total	0 00015	0 00088	8 4E 10	1 3E 8
Future Industrial/Commercial Worker				
Dermal	0	0	2 9E 9	1 6E 7
Ingestion	0	0	1 8E 8	1 8E 7
Total	0	0	2 1E 8	3 4E 7
Current Trespasser/Site Visitor				
Dermal	0	0	1 7E 10	1 4E 8
Ingestion	0	0	7 9E 10	1 1E 8
Total	0	0	9 6E 10	2 4E 8
Hypothetical Future Resident				
Dermal	0	0	2 5E 8	5 3E 7
Ingestion	0	0	3 0E 7	8 2E 7
Total	0	0	3 3E 7	1 4E 6

Attachment A-24 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 7C Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	6.8	6.8	1/1	6.8	6.8	0.03	NE	NE	13.22
Beryllium	mg/kg	0.39	0.39	1/1	0.39	0.39	0	NE	NE	1.01
Chromium	mg/kg	31	31	1/1	31	31	0	3.0E-03	NTV	25.46
Lead	mg/kg	900	900	1/1	900	900	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0.34	0.34	1/1	0.34	0.34	0.13	NTV	7.3	0.74

Hotspot 7C Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg-day) ¹	Background
Arsenic	mg/kg	4.6	6.8	3/3	6.8	5.77	0.03	NE	NE	13.22
Beryllium	mg/kg	0.39	1.1	3/3	1.1	0.76	0	5.0E-03	NTV	1.01
Chromium	mg/kg	31	38	3/3	38	35	0	2.0E-02	NTV	25.46
Lead	mg/kg	8.1	900	3/3	900	307	0	NE	NE	363
Benzo(a)pyrene	mg/kg	0.011	0.34	2/3	0.34	0.13	0.13	NTV	7.3	0.74

¹Present at background level

Lead has no RfD or SF and is evaluated separately

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-24-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	38	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	3 2E 8
													Total	0 0E+0
														3 2E 8

Attachment A-24-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 1	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	7 4E 4	NA
Chromium	38	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	6 4E 3	NA
Benzo(a)pyrene	0 34	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	2 7E 8
										Total	7 1E 3	2 7E 8

Attachment A-24-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.76	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	35	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
Benzo(a)pyrene	0.13	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	8.1E 10
												Total	0.0E+0	8.1E 10

Attachment A-24-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.76	1E 6	100	30	1	70	42	25550	5.0E 03	NTV	1.5E 4	NA
Chromium	35	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.8E 3	NA
Benzo(a)pyrene	0.13	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.6E 9
										Total	1.9E 3	1.6E 9

Attachment A-24-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x 10⁶ kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E 03	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 34	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	7 4E 7	
													Total	0 0E+0	7 4E 7

Attachment A-24-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	1 0E 2	NA	
Benzo(a)pyrene	0 34	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	8 7E 7	
											Total	1 0E 2	8 7E 7

Attachment A-24-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 4E 8
												Total	0 0E+0	1 4E 8

Attachment A-24-9
Future Industrial/Commercial Worker
Estimated Risk for ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	50	250	5	70	1 825	25 550	3 0E 03	NTV	5 1E 3	NA	
Benzo(a)pyrene	0.34	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	8.7E 8	
											Total	5 1E 3	8.7E 8

Attachment A-24-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	6 4E 8
												Total	0 0E+0	6 4E 8

Attachment A-24-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	100	12	30	70	10 950	25 550	3 0E 03	NTV	4 9E 4	NA	
Benzo(a)pyrene	0 34	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	5 0E 8	
											Total	4 9E 4	5 0E 8

Attachment A-24-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
Benzo(a)pyrene	0 34	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	7 8E 10
												Total	0 0E+0	7 8E 10

Attachment A-24-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 2E 4	NA	
Benzo(a)pyrene	0.34	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	3.7E 9	
											Total	1 2E 4	3.7E 9

Attachment A-24-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0	NA
Benzo(a)pyrene	0.34	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.5E 6
															Total	0.0E+0	2.5E 6

Attachment A-24-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Chromium	31	1E 6	200	100	350	6	24	15	70	2 190	25 550	3 0E 03	NTV	1 3E 1	NA	
Benzo(a)pyrene	0.34	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	3.9E 6	
														Total	1 3E 1	3.9E 6

Attachment A-24 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm^2/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	0.0E+0	NA
Benzo(a)pyrene	0.34	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.2E 7
															Total	0.0E+0	1.2E 7

Attachment A-24-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Chromium	31	1E 6	100	50	350	6	3	15	70	2 190	25 550	3 0E 03	NTV	6 6E 2	NA
Benzo(a)pyrene	0.34	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	1.4E 6
														Total	6.6E 2
															1.4E 6

Attachment A-24-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 7C Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	8 1E 10	3 2E 8
Ingestion	0 0019	0 0071	1 6E 9	2 7E 8
Total	0 0019	0 0071	2 4E 9	6 0E 8
Future Industrial/Commercial Worker				
Dermal	0	0	1 4E 8	7 4E 7
Ingestion	0 0051	0 010	8 7E 8	8 7E 7
Total	0 0051	0 010	1 0E 7	1 6E 6
Current Trespasser/Site Visitor				
Dermal	0	0	7 8E 10	6 4E 8
Ingestion	0 00012	0 00049	3 7E 9	5 0E 8
Total	0 00012	0 00049	4 5E 9	1 1E 7
Hypothetical Future Resident				
Dermal	0	0	1 2E 7	2 5E 6
Ingestion	0 066	0 13	1 4E 6	3 9E 6
Total	0 066	0 13	1 5E 6	6 4E 6

Attachment A 25 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 8A Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	6.5	7.9	2/2	7.9	7.2	0.03	NE	NE	13.22
Beryllium	mg/kg	0.3	0.76	2/2	0.78	0.53	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.008	0.21	2/2	0.21	0.11	0.13	NTV	7.3	0.74

Hotspot 8A Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	6.3	8.4	6/6	8	7.3	0.03	NE	NE	13.22
Beryllium	mg/kg	0.3	0.79	6/6	0.73	0.56	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	0.009	2	4/6	1.58	0.68	0.13	NTV	0.73	0.89
Benzo(a)pyrene	mg/kg	0.008	0.99	4/6	0.61	0.25	0.13	NTV	7.3	0.74
Dibenz(a,h)anthracene	mg/kg	0.036	0.14	3/6	0.098	0.06	0.13	NTV	7.3	0.3

¹Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-25-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E 01	NA	1 5E 8
Benzo(a)pyrene	0 61	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	5 8E 8
Dibenz(a h)anthracene	0 098	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	9 3E 9
												Total	0 0E+0	8 2E 8

Attachment A-25-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1 6	1E 6	330	60	1	70	84	25 550	NTV	7 3E 01	NA	1 3E 8
Benzo(a)pyrene	0 61	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	4 9E 8
Dibenz(a,h)anthracene	0 098	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	7 9E 9
Total										0 0E+0		7 0E 8

Attachment A-25-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.68	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	4.3E 10
Benzo(a)pyrene	0.25	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.6E 9
Dibenz(a,h)anthracene	0.06	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.8E 10
												Total	0.0E+0	2.4E 9

Attachment A-25-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.68	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	8.3E 10
Benzo(a)pyrene	0.25	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	3.1E 9
Dibenz(a,h)anthracene	0.06	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	7.3E 10
Total										0.0E+0		4.6E 9

Attachment A-25-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^8 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.21	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.6E-7
												Total	0.0E+0	4.6E-7

Attachment A-25-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.21	1E 6	100	250	25	70	9.125	25.550	NTV	7.3E+00	NA	5.4E-7
										Total	0.0E+0	5.4E-7

Attachment A-25-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.11	1E 6	0.03	0.13	2.000	250	5	70	1.825	25.550	NTV	7.3E+00	NA	4.3E 9
												Total	0.0E+0	4.3E 9

Attachment A-25-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.11	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	2.8E-8
											Total	0.0E+0

Attachment A-25-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.21	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	4.0E-8
													Total	0.0E+0

Attachment A-25-11
Current Trespasser/Site Visitor
Estimated Risk for ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.21	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.1E-8	
											Total	0.0E+0	3.1E-8

Attachment A-25-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.11	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2.5E 10	
													Total	0.0E+0	2.5E 10

Attachment A-25-13
Current Trespasser/Site Visitor
Estimated Risk for ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.11	1E 6	50	6	9	70	3.285	25.550	NTV	7.3E+00	NA	1.2E 9
										Total	0.0E+0	1.2E 9

Attachment A-25-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child}/BW_{child}) + (SA_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.21	1E-6	0.3	0.13	1913	3300	350	6	24	15	70	2190	25550	NTV	7.3E+00	NA	1.6E-6
															Total	0.0E+0	1.6E-6

Attachment A-25-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.21	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.4E 6	
														Total	0.0E+0	2.4E 6

Attachment A-25 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.11	1E-6	0.04	0.13	1440	2000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	3.8E-8
															Total	0.0E+0	3.8E-8

Attachment A-25-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.11	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	4.6E 7
													Total	0.0E+0	4.6E 7

Attachment A-25-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 8A Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	2 4E 9	8 2E 8
Ingestion	0	0	4 6E 9	7 0E 8
Total	0	0	7 0E 9	1 5E 7
Future Industrial/Commercial Worker				
Dermal	0	0	4 3E 9	4 6E 7
Ingestion	0	0	2 8E 8	5 4E 7
Total	0	0	3 2E 8	1 0E 6
Current Trespasser/Site Visitor				
Dermal	0	0	2 5E 10	4 0E 8
Ingestion	0	0	1 2E 9	3 1E 8
Total	0	0	1 5E 9	7 1E 8
Hypothetical Future Resident				
Dermal	0	0	3 8E 8	1 6E 6
Ingestion	0	0	4 6E 7	2 4E 6
Total	0	0	5 0E 7	4 0E 6

Attachment A-26-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot 8B Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	6.4	6.4	1/1	6.4	6.4	0.03	NE	NE	13.22
Beryllium	mg/kg	0.53	0.53	1/1	0.53	0.53	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.18	0.18	1/1	0.18	0.18	0.13	NTV	7.3	0.74

Hotspot 8B Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	5.3	9.2	3/3	9.2	6.97	0.03	NE	NE	13.22
Beryllium	mg/kg	0.53	0.78	3/3	0.78	0.62	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.18	0.33	2/3	0.33	0.18	0.13	NTV	7.3	0.74

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-26-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)¹

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.33	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	3.1E 8	
													Total	0.0E+0	3.1E 8

Attachment A-26-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.33	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	2.7E 8
										Total	0.0E+0	2.7E 8

Attachment A-26-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.1E 9
													Total	0.0E+0

Attachment A-26-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	2.2E-9
										Total	0.0E+0	2.2E-9

Attachment A-26-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor, (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E-6	0.20	0.13	3.300	250	25	70	9.125	25.550	NTV	7.3E+00	NA	3.9E-7
												Total	0.0E+0	3.9E-7

Attachment A-26-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	100	250	25	70	9.125	25.550	NTV	7.3E+00	NA	4.6E-7
											Total	0.0E+0
												4.6E-7

Attachment A-26-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	0.03	0.13	2.000	250	5	70	1.825	25.550	NTV	7.3E+00	NA	7.2E 9
												Total	0.0E+0	7.2E 9

Attachment A-26-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.6E-8
										Total	0.0E+0	4.6E-8

Attachment A-26-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.4E 8
												Total	0.0E+0	3.4E 8

Attachment A-26-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.6E-8
										Total	0.0E+0	2.6E-8

Attachment A-26-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.18	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	4.1E 10	
													Total	0.0E+0	4.1E 10

Attachment A-26-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.0E 9
										Total	0.0E+0	2.0E 9

Attachment A-26-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E+00	NA	1.3E 6
															Total	0.0E+0	1.3E 6

Attachment A-26-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
R_{fD}_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.18	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.1E 6	
														Total	0.0E+0	2.1E 6

Attachment A-26-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _i	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.18	1E 6	0.04	0.13	1.440	2.000	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	6.2E-8
															Total	0.0E+0	6.2E-8

Attachment A-26-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where
HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where
CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.18	1E 6	100	50	350	6	3	15	70	2190	25550	NTV	7.3E+00	NA	7.6E-7	
														Total	0.0E+0	7.6E-7

Attachment A-26-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot 8B Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 1E 9	3 1E 8
Ingestion	0	0	2 2E 9	2 7E 8
Total	0	0	3 4E 9	5 8E 8
Future Industrial/Commercial Worker				
Dermal	0	0	7 2E 9	3 9E 7
Ingestion	0	0	4 6E 8	4 6E 7
Total	0	0	5 3E 8	8 5E 7
Current Trespasser/Site Visitor				
Dermal	0	0	4 1E 10	3 4E 8
Ingestion	0	0	2 0E 9	2 6E 8
Total	0	0	2 4E 9	6 0E 8
Hypothetical Future Resident				
Dermal	0	0	6 2E 8	1 3E 6
Ingestion	0	0	7 6E 7	2 1E 6
Total	0	0	8 2E 7	3 4E 6

Attachment A 27-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot NE Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg-day)	SF _{ref} (mg/kg day) ¹	Background
Arsenic	mg/kg	2.6	2.60	1/1	2.60	2.60	0.03	NE	NE	13.22
Beryllium	mg/kg	0.23	0.23	1/1	0.23	0.23	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	2.2	2.20	1/1	2.20	2.20	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	1.8	1.8	1/1	1.8	1.8	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	2.5	2.5	1/1	2.5	2.5	0.13	NTV	7.3E-01	0.63
Dibenz(a,h)anthracene	mg/kg	0.19	0.19	1/1	0.19	0.19	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	1.1	1.1	1/1	1.1	1.1	0.13	NTV	7.3E-01	0.41

Hotspot NE Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{ref} (mg/kg day)	SF _{ref} (mg/kg-day) ¹	Background
Arsenic	mg/kg	2.1	3.3	1/3	3.3	2.67	0.03	NE	NE	13.22
Beryllium	mg/kg	0.18	0.56	1/3	0.56	0.32	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	0.019	2.2	2/3	2.2	0.79	0.13	NTV	7.3E-01	0.89
Benzo(a)pyrene	mg/kg	0.0080	1.8	2/3	1.8	0.61	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.016	2.5	2/3	2.5	0.85	0.13	NTV	7.3E-01	0.63
Dibenz(a,h)anthracene	mg/kg	0.19	0.19	1/3	0.19	0.09	0.13	NTV	7.3E+00	0.3
Indeno(1,2,3 cd)pyrene	mg/kg	0.0040	1.1	2/3	1.1	0.42	0.13	NTV	7.3E-01	0.41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-27-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.1E 8
Benzo(a)pyrene	1.8	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.7E 7
Benzo(b)fluoranthene	2.5	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.4E 8
Dibenz(a h)anthracene	0.19	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.8E 8
Indeno(1 2 3 cd)pyrene	1.1	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.0E 8
												Total	0.0E+0	2.4E 7

Attachment A-27-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.8E 8
Benzo(a)pyrene	1.8	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.5E 7
Benzo(b)fluoranthene	2.5	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.0E 8
Dibenz(a h)anthracene	0.19	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.5E 8
Indeno(1 2 3 cd)pyrene	1.1	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	8.9E 9
										Total	0.0E+0	2.1E 7

Attachment A-27-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_c = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.79	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	5.1E 10
Benzo(a)pyrene	0.61	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	3.9E 9
Benzo(b)fluoranthene	0.85	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	5.4E 10
Dibenz(a h)anthracene	0.089	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	5.6E 10
Indeno(1 2 3 cd)pyrene	0.42	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	2.7E 10
												Total	0.0E+0	5.8E 9

Attachment A-27-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.79	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	9.7E 10
Benzo(a)pyrene	0.61	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	7.5E 9
Benzo(b)fluoranthene	0.85	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.0E 9
Dibenz(a h)anthracene	0.089	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.1E 9
Indeno(1 2 3 cd)pyrene	0.42	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	5.2E 10
										Total	0.0E+0	1.1E 8

Attachment A-27-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{o al})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{o al} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{o al}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	4.8E 7
Benzo(a)pyrene	1.8	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	3.9E 6
Benzo(b)fluoranthene	2.5	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	5.5E 7
Dibenz(a h)anthracene	0.19	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.2E 7
Indeno(1 2 3 cd)pyrene	1.1	1E 6	0.20	0.13	3 300	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.4E 7
												Total	0.0E+0	5.6E 6

Attachment A-27-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	5.6E 7
Benzo(a)pyrene	1.8	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.6E 6
Benzo(b)fluoranthene	2.5	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	6.4E 7
Dibenz(a h)anthracene	0.19	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E+00	NA	4.8E 7
Indeno(1 2 3 cd)pyrene	1.1	1E 6	100	250	25	70	9 125	25 550	NTV	7.3E 01	NA	2.8E 7
										Total	0.0E+0	6.6E 6

Attachment A-27-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	8.8E 9
Benzo(a)pyrene	1.8	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	7.2E 8
Benzo(b)fluoranthene	2.5	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	9.9E 9
Dibenz(a h)anthracene	0.19	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E+00	NA	7.6E 9
Indeno(1 2 3 cd)pyrene	1.1	1E 6	0.03	0.13	2 000	250	5	70	1 825	25 550	NTV	7.3E 01	NA	4.4E 9
Total												0.0E+0	1.0E 7	

Attachment A-27-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	5.6E 8
Benzo(a)pyrene	1.8	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.6E 7
Benzo(b)fluoranthene	2.5	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	6.4E 8
Dibenz(a h)anthracene	0.19	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	4.8E 8
Indeno(1 2 3 cd)pyrene	1.1	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E 01	NA	2.8E 8
										Total	0.0E+0	6.6E 7

Attachment A-27-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	4.2E 8
Benzo(a)pyrene	1.8	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.4E 7
Benzo(b)fluoranthene	2.5	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	4.7E 8
Dibenz(a,h)anthracene	0.19	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E+00	NA	3.6E 8
Indeno(1,2,3 cd)pyrene	1.1	1E 6	0.3	0.13	3 300	12	30	70	10 950	25 550	NTV	7.3E 01	NA	2.1E 8
												Total	0.0E+0	4.9E 7

Attachment A-27-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	3.2E 8
Benzo(a)pyrene	1.8	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.6E 7
Benzo(b)fluoranthene	2.5	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	3.7E 8
Dibenz(a h)anthracene	0.19	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E+00	NA	2.8E 8
Indeno(1 2 3 cd)pyrene	1.1	1E 6	100	12	30	70	10 950	25 550	NTV	7.3E 01	NA	1.6E 8
Total										0.0E+0		3.8E 7

Attachment A-27-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	5.0E 10
Benzo(a)pyrene	1.8	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	4.1E 9
Benzo(b)fluoranthene	2.5	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	5.7E 10
Dibenz(a h)anthracene	0.19	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E+00	NA	4.4E 10
Indeno(1 2 3 cd)pyrene	1.1	1E 6	0.04	0.13	2 000	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.5E 10
												Total	0.0E+0	5.9E 9

Attachment A-27-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x 10⁻⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.4E 9
Benzo(a)pyrene	1.8	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.0E 8
Benzo(b)fluoranthene	2.5	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	2.8E 9
Dibenz(a,h)anthracene	0.19	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E+00	NA	2.1E 9
Indeno(1,2,3-cd)pyrene	1.1	1E 6	50	6	9	70	3 285	25 550	NTV	7.3E 01	NA	1.2E 9
Total										0.0E+0		2.8E 8

Attachment A-27 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.6E 6
Benzo(a)pyrene	1.8	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.3E 5
Benzo(b)fluoranthene	2.5	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.8E 6
Dibenz(a,h)anthracene	0.19	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.4E 6
Indeno(1,2,3-cd)pyrene	1.1	1E 6	0.3	0.13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	8.1E 7
Total																0.0E+0	1.9E 5

Attachment A-27-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	2.5E 6
Benzo(a)pyrene	1.8	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.1E 5
Benzo(b)fluoranthene	2.5	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	2.9E 6
Dibenz(a,h)anthracene	0.19	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.2E 6
Indeno(1,2,3 cd)pyrene	1.1	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	1.3E 6
Total														0.0E+0	2.9E 5

Attachment A-27 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD	SF	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	7.6E-8
Benzo(a)pyrene	1.8	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	6.2E-7
Benzo(b)fluoranthene	2.5	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.6E-8
Dibenz(a h)anthracene	0.19	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	6.5E-8
Indeno(1 2 3 cd)pyrene	1.1	1E-6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	3.8E-8
Total																0.0E+0	8.8E-7

Attachment A-27-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.2	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	9.3E 7
Benzo(a)pyrene	1.8	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	7.6E 6
Benzo(b)fluoranthene	2.5	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	1.1E 6
Dibenz(a,h)anthracene	0.19	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	8.0E 7
Indeno(1,2,3 cd)pyrene	1.1	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E 01	NA	4.6E 7
Total														0.0E+0	1.1E 5

Attachment A-27-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot NE Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	5 8E 9	2 4E 7
Ingestion	0	0	1 1E 8	2 1E 7
Total	0	0	1 7E 8	4 5E 7
Future Industrial/Commercial Worker				
Dermal	0	0	1 0E 7	5 6E 6
Ingestion	0	0	6 6E 7	6 6E 6
Total	0	0	7 6E 7	1 2E 5
Current Trespasser/Site Visitor				
Dermal	0	0	5 9E 9	4 9E 7
Ingestion	0	0	2 8E 8	3 8E 7
Total	0	0	3 4E 8	8 6E 7
Hypothetical Future Resident				
Dermal	0	0	8 8E 7	1 9E 5
Ingestion	0	0	1 1E 5	2 9E 5
Total	0	0	1 2E 5	4 8E 5

Attachment A 28 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDA Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4	4	1/1	4	4	0.03	NE	NE	13.22
Beryllium	mg/kg	0.61	0.61	1/1	0.61	0.61	0	NE	NE	1.01

Hotspot RDA Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{rel} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4	9.4	3/3	9.4	6.67	0.03	NE	NE	13.22
Beryllium	mg/kg	0.61	0.7	3/3	0.70	0.64	0	NE	NE	1.01
Benzo(a)anthracene	mg/kg	0.091	1.2	3/3	1.2	0.47	0.13	NTV	7.3E 01	0.89
Benzo(a)pyrene	mg/kg	0.1	1.1	3/3	1.1	0.44	0.13	NTV	7.3E+00	0.74
Benzo(b)fluoranthene	mg/kg	0.13	1.5	3/3	1.5	0.61	0.13	NTV	7.3E 01	0.63
Dibenz(a,h)anthracene	mg/kg	0.014	0.16	3/3	0.16	0.06	0.13	NTV	7.3E+00	0.3

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-28-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.2	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.1E 8
Benzo(a)pyrene	1.1	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.0E 7
Benzo(b)fluoranthene	1.5	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.4E 8
Dibenz(a h)anthracene	0.16	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	1.5E 8
												Total	0.0E+0	1.4E 7

Attachment A-28-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.47	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	5.8E 10
Benzo(a)pyrene	0.44	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	5.4E 9
Benzo(b)fluoranthene	0.61	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	7.4E 10
Dibenz(a h)anthracene	0.064	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	7.8E 10
									Total	0.0E+0		7.5E 9

Attachment A-28-4
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.2	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	9.7E 9
Benzo(a)pyrene	1.1	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	8.9E 8
Benzo(b)fluoranthene	1.5	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.2E 8
Dibenz(a h)anthracene	0.16	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.3E 8
										Total	0.0E+0	1.2E 7

Attachment A-28-5
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	0.47	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	3.0E 10
Benzo(a)pyrene	0.44	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	2.8E 9
Benzo(b)fluoranthene	0.61	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	3.9E 10
Dibenz(a h)anthracene	0.064	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	4.1E 10
												Total	0.0E+0	3.9E 9

Attachment A-28-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	3 9E 9	1 4E 7
Ingestion	0	0	7 5E 9	1 2E 7
Total	0	0	1 1E 8	2 7E 7

Attachment A 29-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDB Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Antimony	mg/kg	34	34	1/1	34	34	0	4.0E-04	NTV	NE
Arsenic	mg/kg	8.6	8.6	1/1	8.6	8.6	0.03	NE	NE	13.22
Beryllium	mg/kg	0.63	0.63	1/1	0.63	0.63	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.22	0.22	1/1	0.22	0.22	0.13	NTV	7.3E+00	0.74

Hotspot RDB Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Antimony	mg/kg	3.8	34	3/3	34	14.03	0	4.0E-04	NTV	NE
Arsenic	mg/kg	3.6	8.6	3/3	8.6	16.10	0.03	NE	NE	13.22
Beryllium	mg/kg	0.54	0.63	3/3	0.63	0.58	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.22	0.22	1/3	0.22	0.09	0.13	NTV	7.3E+00	0.74

¹Present at background level.

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-29-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	0 9	0	3 300	60	1	70	84	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 22	1E 6	0 9	0 13	3 300	60	1	70	84	25 550	NTV	7 3E+00	NA	2 1E 8	
													Total	0 0E+0	2 1E 8

Attachment A-29-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	330	60	1	70	84	25 550	4 0E 04	NTV	2 9E 1	NA
Benzo(a)pyrene	0.22	1E 6	330	60	1	70	84	25 550	NTV	7 3E+00	NA	1 8E 8
										Total	2 9E 1	1 8E 8

Attachment A-29-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	14	1E 6	0 2	0	2 000	30	1	70	42	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 094	1E 6	0 2	0 13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	6 0E 10	
													Total	0 0E+0	6 0E 10

Attachment A-29-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	14	1E 6	100	30	1	70	42	25 550	4 0E 04	NTV	3 6E 2	NA
Benzo(a)pyrene	0 094	1E 6	100	30	1	70	42	25 550	NTV	7 3E+00	NA	1 2E 9
										Total	3 6E 2	1 2E 9

Attachment A-29-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x 10⁶ kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 22	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 8E 7	
													Total	0 0E+0	4 8E 7

Attachment A-29-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	8 3E 2	NA	
Benzo(a)pyrene	0 22	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	5 6E 7	
											Total	8 3E 2	5 6E 7

Attachment A-29-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^8 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 22	1E 6	0 03	0 13	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	8 8E 9	
													Total	0 0E+0	8 8E 9

Attachment A-29-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	50	250	5	70	1 825	25 550	4 0E 04	NTV	4 2E 2	NA	
Benzo(a)pyrene	0.22	1E 6	50	250	5	70	1 825	25 550	NTV	7.3E+00	NA	5.6E 8	
											Total	4 2E 2	5.6E 8

Attachment A-29-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	0 3	0	3 300	12	30	70	10 950	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 22	1E 6	0 3	0 13	3 300	12	30	70	10 950	25 550	NTV	7 3E+00	NA	4 2E 8	
													Total	0 0E+0	4 2E 8

Attachment A-29-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	100	12	30	70	10 950	25 550	4 0E 04	NTV	4 0E 3	NA	
Benzo(a)pyrene	0 22	1E 6	100	12	30	70	10 950	25 550	NTV	7 3E+00	NA	3 2E 8	
											Total	4 0E 3	3 2E 8

Attachment A-29-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	4 0E 04	NTV	0 0E+0	NA	
Benzo(a)pyrene	0 22	1E 6	0 04	0 13	2 000	6	9	70	3 285	25 550	NTV	7 3E+00	NA	5 0E 10	
													Total	0 0E+0	5 0E 10

Attachment A-29-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1 x10⁶ kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	50	6	9	70	3 285	25 550	4 0E 04	NTV	1 0E 3	NA	
Benzo(a)pyrene	0 22	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	2 4E 9	
											Total	1 0E 3	2 4E 9

Attachment A-29-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{ad} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{ad} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{ad} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ EF \ SF_{oral} ((SA_{child} \ ED_{child}/BW_{child}) + (SA_{ad} \ ED_{ad}/BW_{ad}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{ad}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	0	NA
Benzo(a)pyrene	0 22	1E 6	0 3	0 13	1 913	3 300	350	6	24	15	70	2 190	25 550	NTV	7 3E+00	NA	1 6E 6
															Total	0 0E+0	1 6E 6

Attachment A-29-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_c \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	200	100	350	6	24	15	70	2 190	25 550	4 0E 04	NTV	1 1E+0	NA
Benzo(a)pyrene	0.22	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	2.5E 6
													Total	1 1E+0	2.5E 6

Attachment A-29-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_c = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Antimony	34	1E 6	0 04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	0 0E+0	NA
Benzo(a)pyrene	0 22	1E 6	0 04	0 13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7 3E+00	NA	7 6E 8
Total															0 0E+0	7 6E 8	

Attachment A-29-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years).
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Antimony	34	1E 6	100	50	350	6	3	15	70	2 190	25 550	4 0E 04	NTV	5 4E 1	NA	
Benzo(a)pyrene	0.22	1E 6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	9.3E 7	
														Total	5.4E 1	9.3E 7

Attachment A-29-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	6 0E 10	2 1E 8
Ingestion	0 036	0 29	1 2E 9	1 8E 8
Total	<u>0 036</u>	<u>0 29</u>	<u>1 7E 9</u>	<u>3 9E 8</u>
Future Industrial/Commercial Worker				
Dermal	0	0	8 8E 9	4 8E 7
Ingestion	0 042	0 083	5 6E 8	5 6E 7
Total	<u>0 042</u>	<u>0 083</u>	<u>6 5E 8</u>	<u>1 0E 6</u>
Current Trespasser/Site Visitor				
Dermal	0	0	5 0E 10	4 2E 8
Ingestion	0 0010	0 0040	2 4E 9	3 2E 8
Total	<u>0 0010</u>	<u>0 0040</u>	<u>2 9E 9</u>	<u>7 4E 8</u>
Hypothetical Future Resident				
Dermal	0	0	7 6E 8	1 6E 6
Ingestion	0 54	1 1	9 3E 7	2 5E 6
Total	<u>0 54</u>	<u>1 1</u>	<u>1 0E 6</u>	<u>4 1E 6</u>

Attachment A 30-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RDC Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	0.67	4.7	2/2	4.7	27	0.03	NE	NE	13.22
Beryllium	mg/kg	0.76	6.7	2/2	6.7	37	0	2.0E-03	NTV	1.01
Chromium	mg/kg	31	37	2/2	37	34	0	3.0E-03	NTV	25.46

Hotspot RDC Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg-day) ¹	Background
Arsenic	mg/kg	0.67	6.6	6/6	5.9	43	0.03	NE	NE	13.22
Beryllium	mg/kg	0.76	6.7	6/6	3.6	21	0	5.0E-03	NTV	1.01
Chromium	mg/kg	24	37	6/6	34	30	0	2.0E-02	NTV	25.46

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-30-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3.6	1E 6	0.9	0	3 300	60	1	70	84	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	34	1E 6	0.9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-30-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3.6	1E 6	330	60	1	70	84	25 550	5.0E 03	NTV	2.4E 3	NA
Chromium	34	1E 6	330	60	1	70	84	25 550	2.0E 02	NTV	5.7E 3	NA
										Total	8.1E 3	0.0E+0

Attachment A-30-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	2 1	1E 6	0 2	0	2 000	30	1	70	42	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	30	1E 6	0 2	0	2 000	30	1	70	42	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	2 1	1E 6	100	30	1	70	42	25 550	5 0E 03	NTV	4 2E 4	NA
Chromium	30	1E 6	100	30	1	70	42	25 550	2 0E 02	NTV	1 5E 3	NA
										Total	2 0E 3	0 0E+0

Attachment A-30-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	6.7	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	37	1E 6	0.20	0	3 300	250	25	70	9 125	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-30-7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	6.7	1E 6	100	250	25	70	9 125	25 550	2.0E 03	NTV	3.3E 3	NA
Chromium	37	1E 6	100	250	25	70	9 125	25 550	3.0E 03	NTV	1.2E 2	NA
										Total	1.5E 2	0.0E+0

Attachment A-30-8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 03	0	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0.5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3.7	1E 6	50	250	5	70	1 825	25 550	2.0E 03	NTV	9.1E 4	NA
Chromium	34	1E 6	50	250	5	70	1 825	25 550	3.0E 03	NTV	5.5E 3	NA
										Total	6.5E 3	0.0E+0

Attachment A-30-10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	6.7	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	37	1E 6	0.3	0	3 300	12	30	70	10 950	25 550	3.0E 03	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-30-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	6.7	1E 6	100	12	30	70	10 950	25 550	2.0E 03	NTV	1.6E 4	NA
Chromium	37	1E 6	100	12	30	70	10 950	25 550	3.0E 03	NTV	5.8E 4	NA
										Total	7.4E 4	0.0E+0

Attachment A-30-12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	2 0E 03	NTV	0 0E+0	NA
Chromium	34	1E 6	0 04	0	2 000	6	9	70	3 285	25 550	3 0E 03	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-30-13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3 7	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	2 2E 5	NA
Chromium	34	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	1 3E 4	NA
										Total	1 5E 4	0 0E+0

Attachment A-30-14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_c \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^{-6} kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT	RfD	SF	Hazard Index	Cancer Risk
Beryllium	6.7	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	0	NA
Chromium	37	1E 6	0.3	0	1 913	3 300	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	0	NA
															Total	0.0E+0	0.0E+0

Attachment A-30-15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR_{child} = Soil Ingestion Rate for a Child (mg/day)
 IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	6.7	1E-6	200	100	350	6	24	15	70	2190	25550	2.0E-03	NTV	4.3E-2	NA
Chromium	37	1E-6	200	100	350	6	24	15	70	2190	25550	3.0E-03	NTV	1.6E-1	NA
													Total	2.0E-1	0.0E+0

Attachment A-30-16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^6 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _c	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	3.7	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	0.0E+0	NA
Chromium	34	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	0.0E+0	NA
															Total	0.0E+0	0.0E+0

Attachment A-30-17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR_{child} \ EF \ ED_{child}) / (BW_{child} \ AT_{nc} \ RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^6 kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ EF \ SF_{oral} ((IR_{child} \ ED_{child}/BW_{child}) + (IR_{adult} \ ED_{adult}/BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT_c = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Beryllium	3.7	1E 6	100	50	350	6	3	15	70	2 190	25 550	2.0E 03	NTV	1.2E 2	NA	
Chromium	34	1E 6	100	50	350	6	3	15	70	2 190	25 550	3.0E 03	NTV	7.2E 2	NA	
														Total	8.4E 2	0.0E+0

Attachment A-30-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RDC Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 0020	0 0081	0 0E+0	0 0E+0
Total	<u>0 0020</u>	<u>0 0081</u>	<u>0 0E+0</u>	<u>0 0E+0</u>
Future Industrial/Commercial Worker				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 0065	0 015	0 0E+0	0 0E+0
Total	<u>0 0065</u>	<u>0 015</u>	<u>0 0E+0</u>	<u>0 0E+0</u>
Current Trespasser/Site Visitor				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 00015	0 00074	0 0E+0	0 0E+0
Total	<u>0 00015</u>	<u>0 00074</u>	<u>0 0E+0</u>	<u>0 0E+0</u>
Hypothetical Future Resident				
Dermal	0	0	0 0E+0	0 0E+0
Ingestion	0 084	0 20	0 0E+0	0 0E+0
Total	<u>0 084</u>	<u>0 20</u>	<u>0 0E+0</u>	<u>0 0E+0</u>

Attachment A-31-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot RR Surface Soil (0-0.5 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.6	4.6	1/1	4.6	4.6	0.03	NE	NE	13.22
Beryllium	mg/kg	0.6	0.6	1/1	0.6	0.6	0	NE	NE	1.01

Hotspot RR Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4.6	8.4	3/3	8.4	5.9	0.03	NE	NE	13.22
Beryllium	mg/kg	0.6	1.3	3/3	1.3	0.87	0	5.0E-03	NTV	1.01
Chromium	mg/kg	23	48	3/3	48	33	0	2.0E-02	NTV	25.46

¹Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-31-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)¹

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	0 9	0	3 300	60	1	70	84	25 550	5 0E 03	NTV	0 0E+0	NA
Chromium	48	1E 6	0 9	0	3 300	60	1	70	84	25 550	2 0E 02	NTV	0 0E+0	NA
												Total	0 0E+0	0 0E+0

Attachment A-31-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	1 3	1E 6	330	60	1	70	84	25 550	5 0E 03	NTV	8 8E 4	NA
Chromium	48	1E 6	330	60	1	70	84	25 550	2 0E 02	NTV	8 1E 3	NA
										Total	9 0E 3	0 0E+0

Attachment A-31-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF AD AB SA EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF AD AB SA EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.87	1E 6	0.2	0	2 000	30	1	70	42	25 550	5.0E 03	NTV	0.0E+0	NA
Chromium	33.00	1E 6	0.2	0	2 000	30	1	70	42	25 550	2.0E 02	NTV	0.0E+0	NA
												Total	0.0E+0	0.0E+0

Attachment A-31-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Beryllium	0.87	1E 6	100	30	1	70	42	25 550	5.0E 03	NTV	1.8E 4	NA
Chromium	33.00	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.7E 3	NA
										Total	1.9E 3	0.0E+0

Attachment A-31-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot RR
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	0	0
Ingestion	0 0019	0 0090	0	0
Total	<u>0 0019</u>	<u>0 0090</u>	<u>0</u>	<u>0</u>

Attachment A-32-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot SEA Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	4 1	4 3	2/2	4 3	4 2	0 03	NE	NE	13 22
Beryllium	mg/kg	0 66	0 73	2/2	0 73	0 70	0	NE	NE	1 01
Benzo(a)anthracene	mg/kg	2 6	2 6	1/2	2 6	1 38	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	2 1	2 1	1/2	2 1	1 07	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	2 5	2 5	1/2	2 5	1 33	0 13	NTV	7 3E 01	0 63
Dibenz(a h)anthracene	mg/kg	0 36	0 36	1/2	0 36	0 20	0 13	NTV	7 3E+00	0 3
Indeno(1 2 3 cd)pyrene	mg/kg	1 4	1 4	1/2	1 4	0 78	0 13	NTV	7 3E 01	0 41

Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-32-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT_c)

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.6	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.5E 8
Benzo(a)pyrene	2.1	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	2.0E 7
Benzo(b)fluoranthene	2.5	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	2.4E 8
Dibenz(a h)anthracene	0.36	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	3.4E 8
Indeno(1 2 3 cd)pyrene	1.4	1E 6	0.9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E 01	NA	1.3E 8
												Total	0.0E+0	2.9E 7

Attachment A-32-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{oral}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = (\text{CS CF IR EF ED SF}_{\text{oral}}) / (\text{BW AT}_c)$$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	2.6	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.1E 8
Benzo(a)pyrene	2.1	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.7E 7
Benzo(b)fluoranthene	2.5	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	2.0E 8
Dibenz(a,h)anthracene	0.36	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	2.9E 8
Indeno(1,2,3-cd)pyrene	1.4	1E 6	330	60	1	70	84	25 550	NTV	7.3E 01	NA	1.1E 8
										Total	0.0E+0	2.5E 7

Attachment A-32-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where
 HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where
 CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.38	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	8.8E 10
Benzo(a)pyrene	1.07	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	6.8E 9
Benzo(b)fluoranthene	1.33	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	8.5E 10
Dibenz(a h)anthracene	0.20	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E+00	NA	1.2E 9
Indeno(1 2 3 cd)pyrene	0.78	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7.3E 01	NA	5.0E 10
Total												0.0E+0		1.0E 8

Attachment A-32-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)anthracene	1.38	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.7E 9
Benzo(a)pyrene	1.07	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.3E 8
Benzo(b)fluoranthene	1.33	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.6E 9
Dibenz(a h)anthracene	0.20	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	2.4E 9
Indeno(1 2 3 cd)pyrene	0.78	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	9.6E 10
										Total	0.0E+0	2.0E 8

Attachment A-32-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot SEA Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 0E 8	2 9E 7
Ingestion	0	0	2 0E 8	2 5E 7
Total	0	0	3 0E 8	5 5E 7

Attachment A 33 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hotspot SEB Combined Surface and Subsurface Soil (0-10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Arsenic	mg/kg	6.9	7.3	1/2	17.3	7.1	0.03	NE	NE	13.22
Beryllium	mg/kg	0.58	0.66	1/2	0.66	0.62	0	NE	NE	1.01
Benzo(a)pyrene	mg/kg	0.18	0.18	1/2	0.18	0.18	0.13	NTV	7.3E-00	0.74

¹Present at background level

NE Not evaluated quantitatively

NTV No toxicity value

Attachment A-33-2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ AD \ AB \ SA \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

AD = Adherence Factor for Soil (mg/cm²)

AB = Absorbed Fraction (unitless)

SA = Surface Area of Exposed Skin (cm²/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ AD \ AB \ SA \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk	
Benzo(a)pyrene	0.18	1E 6	0.9	0.13	3.300	60	1	70	84	25.550	NTV	7.3E+00	NA	1.7E 8	
													Total	0.0E+0	1.7E 8

Attachment A-33-3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.5E-8
										Total	0.0E+0	1.5E-8

Attachment A-33-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT_c)$

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	0.2	0.13	2 000	30	1	70	42	25 550	NTV	7 3E+00	NA	1 1E 9
													Total	0 0E+0

Attachment A-33-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0-10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \ CF \ IR \ EF \ ED) / (BW \ AT_{nc} \ RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^6 kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \ CF \ IR \ EF \ ED \ SF_{oral}) / (BW \ AT_c)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Benzo(a)pyrene	0.18	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	2.2E-9
									Total	0.0E+0		2.2E-9

Attachment A-33-6
Summary of Cancer Risks and Non-Cancer Hazard Indices
Hotspot SEB Area
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0	0	1 1E 9	1 7E 8
Ingestion	0	0	2 2E 9	1 5E 8
Total	<hr/> 0	<hr/> 0	<hr/> 3 4E 9	<hr/> 3 2E 8

Attachment A 34 1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Site-Wide Surface Soil

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg-day)	SF _{oral} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	4 90E-07	2 00E-04	31/31	5 50E-05	3 40E-05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0049	14	23/189	3 1	1 3	0 14	2 0E 05	2/1	
PCB 1254	mg/kg	0 0065	0 35	17/193	0 35	0 35	0 14	2 0E-05	2/1	
4,4 DDE	mg/kg	0 0006	65	29/41	4 3	1 6	0 03	5 0E-04	3 4E 01	
4,4 DDT	mg/kg	0 0012	1100	30/41	72	27	0 03	5 0E 04	3 4E 01	
Antimony	mg/kg	1 9	34	72/175	8 3	7 8	0	4 0E-04	NTV	
Arsenic	mg/kg	0 67	14	173/173	6 0	5 7	0 03	3 0E 04	1 5E+00	13 22
Beryllium	mg/kg	0 088	6 7	172/172	0 73	0 67	0	2 0E 03	NTV	1 01
Chromium	mg/kg	2	151	172/172	24	23	0	3 0E 03	NTV	25 46
Copper	mg/kg	1 6	126	171/172	39	27	0	4 0E 02	NTV	59 1
Lead	mg/kg	2 1	1790	164/172	68	48	0	NTV	NTV	363
Mercury	mg/kg	0 008	1 5	160/172	0 079	0 06	0	3 0E 04	NTV	0 15
Benzo(a)anthracene	mg/kg	0 002	25	124/156	0 36	0 26	0 13	NTV	7 3E-01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	122/156	0 48	0 28	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 003	16	122/156	0 35	0 26	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	122/154	0 21	0 16	0 13	NTV	7 3E 02	0 46
Dibenz(a,h)anthracene	mg/kg	0 002	7 1	69/154	0 16	0 081	0 13	NTV	7 3E+00	0 3
Indeno(1,2,3-cd)pyrene	mg/kg	0 001	11	117/156	0 25	0 19	0 13	NTV	7 3E 01	0 41

Site-Wide Combined Surface and Subsurface Soil (0 to 10 feet BGS)

Chemical	units	Minimum Detect	Maximum Detect	Frequency of Detection	RME	CTE	Dermal Absorption (unitless)	Chronic RfD _{oral} (mg/kg day)	SF _{oral} (mg/kg day) ¹	Background
Dioxin TEQ	mg/kg	4 9E-07	3 0E-04	70/70	3 6E-05	2 3E-05	0 03	NTV	1 5E+05	
PCB 1248	mg/kg	0 0049	14	45/549	1 1	0 51	0 14	5 0E 05	2/1	
PCB 1254	mg/kg	0 0065	0 35	18/553	0 35	0 35	0 14	5 0E 05	2/1	
4,4 DDE	mg/kg	0 0006	65	28/67	2 6	1 0	0 03	5 0E 04	3 4E 01	
4,4 DDT	mg/kg	0 0006	1100	54/88	34	13	0 03	5 0E 04	3 4E 01	
Antimony	mg/kg	1 8	34	239/502	7 5	7 3	0	4 0E 04	NTV	
Arsenic	mg/kg	0 67	14	500/500	5 5	5 4	0 03	3 0E 04	1 5E+00	13 22
Beryllium	mg/kg	0 0087	6 7	499/499	0 71	0 67	0	5 0E-03	NTV	1 01
Chromium	mg/kg	2	151	499/499	23	22	0	2 0E 02	NTV	25 46
Copper	mg/kg	1 6	1260	498/499	22	18	0	4 0E 02	NTV	59 1
Lead	mg/kg	2 1	1790	450/499	32	25	0	NTV	NTV	363
Mercury	mg/kg	0 008	1 5	446/500	0 049	0 041	0	3 0E 03	NTV	0 15
Benzo(a)anthracene	mg/kg	0 002	25	251/458	0 32	0 22	0 13	NTV	7 3E 01	0 89
Benzo(a)pyrene	mg/kg	0 002	19	241/458	0 21	0 14	0 13	NTV	7 3E+00	0 74
Benzo(b)fluoranthene	mg/kg	0 001	16	249/458	0 27	0 21	0 13	NTV	7 3E 01	0 63
Benzo(k)fluoranthene	mg/kg	0 002	19	252/451	0 23	0 16	0 13	NTV	7 3E 02	0 46
Dibenz(a,h)anthracene	mg/kg	0 001	7 1	115/453	0 078	0 052	0 13	NTV	7 3E+00	0 3
Indeno(1,2,3-cd)pyrene	mg/kg	0 001	11	228/455	0 20	0 15	0 13	NTV	7 3E 01	0 41

The RfD for PCB 1254 was used to evaluate PCB 1248

Lead has no RfD or SF and is evaluated separately

IRIS recommends using a slope factor of 2.0 for RME and 1.0 for CTE

NTV No toxicity value

Attachment A 34 2
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm^2)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm^2/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{rel}) / (BW \cdot AT)$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	3.60E-05	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	NTV	1.5E+05	NA	1.6E 8
PCB 1248	1 1	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5.0E-05	2.0E+00	9.3E 2	3.1E-8
PCB 1254	0.35	1E 6	0 9	0 14	3 300	60	1	70	84	25 550	5.0E-05	2.0E+00	3.0E 2	9.8E 9
4,4 DDE	2 6	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	5.0E 04	3.4E-01	4.7E 3	2.6E 9
4,4 DDT	34	1E-6	0 9	0 03	3 300	60	1	70	84	25 550	5.0E-04	3.4E 01	6.2E 2	3.5E 8
Antimony	7 5	1E-6	0 9	0	3 300	60	1	70	84	25 550	4.0E 04	NTV	0.0E+0	NA
Arsenic	5 5	1E 6	0 9	0 03	3 300	60	1	70	84	25 550	3.0E 04	1.5E+00	1.7E 2	2.5E 8
Beryllium	0.71	1E-6	0 9	0	3 300	60	1	70	84	25 550	5.0E-03	NTV	0.0E+0	NA
Chromium	23	1E-6	0 9	0	3 300	60	1	70	84	25 550	2.0E 02	NTV	0.0E+0	NA
Copper	22	1E-6	0 9	0	3 300	60	1	70	84	25 550	4.0E 02	NTV	0.0E+0	NA
Lead	32	1E-6	0 9	0	3 300	60	1	70	84	25 550	NTV	NTV	NA	NA
Mercury	0.049	1E 6	0 9	0	3 300	60	1	70	84	25 550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)anthracene	0.32	1E 6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E-01	NA	3.0E 9
Benzo(a)pyrene	0.21	1E 6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	2.0E 8
Benzo(b)fluoranthene	0.27	1E-6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E-01	NA	2.6E 9
Benzo(k)fluoranthene	0.23	1E 6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E-02	NA	2.2E 10
Dibenz(a,h)anthracene	0.078	1E 6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E+00	NA	7.4E 9
Indeno(1,2,3-cd)pyrene	0.2	1E 6	0 9	0.13	3 300	60	1	70	84	25 550	NTV	7.3E-01	NA	1.9E 9
Total												2.1E 1	1.5E 7	

Attachment A-34 3
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)

CS = Concentration of Chemical in Soil (mg/kg)

CF = Conversion Factor (1×10^{-6} kg/mg)

IR = Soil Ingestion Rate for an Adult (mg/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration for an Adult (years)

BW = Body Weight for an Adult (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT)$

Where CR = Cancer Risk (unitless)

AT = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

	CS	CF	IR	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	3.60E-05	1E-6	330	60	1	70	84	25 550	NTV	1.5E+05	NA	6.0E-8
PCB 1248	1.1	1E-6	330	60	1	70	84	25 550	5.0E-05	2.0E+00	7.4E-2	2.4E-8
PCB 1254	0.35	1E-6	330	60	1	70	84	25 550	5.0E-05	2.0E+00	2.4E-2	7.7E-9
4,4-DDE	2.6	1E-6	330	60	1	70	84	25 550	5.0E-04	3.4E-01	1.8E-2	9.8E-9
4,4-DDT	34	1E-6	330	60	1	70	84	25 550	5.0E-04	3.4E-01	2.3E-1	1.3E-7
Antimony	7.5	1E-6	330	60	1	70	84	25 550	4.0E-04	NTV	6.3E-2	NA
Arsenic	5.5	1E-6	330	60	1	70	84	25 550	3.0E-04	1.5E+00	6.2E-2	9.1E-8
Beryllium	0.71	1E-6	330	60	1	70	84	25 550	5.0E-03	NTV	4.8E-4	NA
Chromium	23	1E-6	330	60	1	70	84	25 550	2.0E-02	NTV	3.9E-3	NA
Copper	22	1E-6	330	60	1	70	84	25 550	4.0E-02	NTV	1.9E-3	NA
Lead	32	1E-6	330	60	1	70	84	25 550	NTV	NTV	NA	NA
Mercury	0.049	1E-6	330	60	1	70	84	25 550	3.0E-03	NTV	5.5E-5	NA
Benzo(a)anthracene	0.32	1E-6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	2.6E-9
Benzo(a)pyrene	0.21	1E-6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	1.7E-8
Benzo(b)fluoranthene	0.27	1E-6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	2.2E-9
Benzo(k)fluoranthene	0.23	1E-6	330	60	1	70	84	25 550	NTV	7.3E-02	NA	1.9E-10
Dibenz(a,h)anthracene	0.078	1E-6	330	60	1	70	84	25 550	NTV	7.3E+00	NA	6.3E-9
Indeno(1,2,3-cd)pyrene	0.2	1E-6	330	60	1	70	84	25 550	NTV	7.3E-01	NA	1.6E-9
										Total	4.8E-1	3.5E-7

Attachment A-34-4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^6 kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT)$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	2.30E 05	1E-6	0.2	0.03	2.000	30	1	70	42	25.550	NTV	1.5E+05	NA	6.9E 10
PCB 1248	0.51	1E-6	0.2	0.14	2.000	30	1	70	42	25.550	5.0E-05	1.0E+00	5.8E 3	4.8E 10
PCB 1254	0.35	1E-6	0.2	0.14	2.000	30	1	70	42	25.550	5.0E 05	1.0E+00	4.0E 3	3.3E 10
4,4 DDE	1	1E-6	0.2	0.03	2.000	30	1	70	42	25.550	5.0E 04	3.4E-01	2.4E 4	6.8E 11
4,4 DDT	13	1E-6	0.2	0.03	2.000	30	1	70	42	25.550	5.0E 04	3.4E-01	3.2E 3	8.9E 10
Antimony	7.3	1E 6	0.2	0	2.000	30	1	70	42	25.550	4.0E-04	NTV	0.0E+0	NA
Arsenic	5.4	1E-6	0.2	0.03	2.000	30	1	70	42	25.550	3.0E-04	1.5E+00	2.2E 3	1.6E 9
Beryllium	0.67	1E 6	0.2	0	2.000	30	1	70	42	25.550	5.0E-03	NTV	0.0E+0	NA
Chromium	22	1E-6	0.2	0	2.000	30	1	70	42	25.550	2.0E-02	NTV	0.0E+0	NA
Copper	18	1E-6	0.2	0	2.000	30	1	70	42	25.550	4.0E 02	NTV	0.0E+0	NA
Lead	25	1E 6	0.2	0	2.000	30	1	70	42	25.550	NTV	NTV	NA	NA
Mercury	0.041	1E-6	0.2	0	2.000	30	1	70	42	25.550	3.0E-03	NTV	0.0E+0	NA
Benzo(a)anthracene	0.22	1E-6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E 01	NA	1.4E 10
Benzo(a)pyrene	0.14	1E 6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E+00	NA	8.9E 10
Benzo(b)fluoranthene	0.21	1E 6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E-01	NA	1.3E 10
Benzo(k)fluoranthene	0.16	1E-6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E 02	NA	1.0E 11
Dibenz(a,h)anthracene	0.052	1E 6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E+00	NA	3.3E 10
Indeno(1,2,3 cd)pyrene	0.15	1E-6	0.2	0.13	2.000	30	1	70	42	25.550	NTV	7.3E 01	NA	9.6E 11
Total												1.5E 2	5.7E 9	

Attachment A-34-5
Future Excavation/Construction Worker
Estimated Risk for Ingestion of Surface and Subsurface Soil
COPCs 0 10 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{ref})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{ref})/(BW AT_c)

Where CR = Cancer Risk (unitless)
 AT_c = Averaging Time for Carcinogens (25 550 days)
 SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
Dioxin TEQ	2.30E 05	1E 6	100	30	1	70	42	25 550	NTV	1.5E+05	NA	5.8E 9
PCB 1248	0.51	1E 6	100	30	1	70	42	25 550	5.0E 05	1.0E+00	1.0E 2	8.6E 10
PCB 1254	0.35	1E 6	100	30	1	70	42	25 550	5.0E-05	1.0E+00	7.1E 3	5.9E 10
4,4 DDE	1	1E 6	100	30	1	70	42	25 550	5.0E-04	3.4E 01	2.0E 3	5.7E 10
4,4 DDT	13	1E 6	100	30	1	70	42	25 550	5.0E-04	3.4E 01	2.7E 2	7.4E 9
Antimony	7.3	1E 6	100	30	1	70	42	25 550	4.0E 04	NTV	1.9E 2	NA
Arsenic	5.4	1E 6	100	30	1	70	42	25 550	3.0E-04	1.5E+00	1.8E 2	1.4E 8
Beryllium	0.67	1E-6	100	30	1	70	42	25 550	5.0E 03	NTV	1.4E 4	NA
Chromium	22	1E 6	100	30	1	70	42	25 550	2.0E 02	NTV	1.1E 3	NA
Copper	18	1E 6	100	30	1	70	42	25 550	4.0E 02	NTV	4.6E 4	NA
Lead	25	1E 6	100	30	1	70	42	25 550	NTV	NTV	NA	NA
Mercury	0.041	1E 6	100	30	1	70	42	25 550	3.0E 03	NTV	1.4E 5	NA
Benzo(a)anthracene	0.22	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.7E 10
Benzo(a)pyrene	0.14	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	1.7E 9
Benzo(b)fluoranthene	0.21	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	2.6E 10
Benzo(k)fluoranthene	0.16	1E 6	100	30	1	70	42	25 550	NTV	7.3E 02	NA	2.0E 11
Dibenz(a,h)anthracene	0.052	1E 6	100	30	1	70	42	25 550	NTV	7.3E+00	NA	6.4E 10
Indeno(1,2,3-cd)pyrene	0.15	1E 6	100	30	1	70	42	25 550	NTV	7.3E 01	NA	1.8E 10
Total										8.5E 2	3.2E 8	

Attachment A 34-6
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{rel})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot AD \cdot AB \cdot SA \cdot EF \cdot ED \cdot SF_{oral}) / (BW \cdot AT)$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{rel}	Hazard Index	Cancer Risk	
Dioxin TEQ	5 50E 05	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	NTV	1 5E+05	NA	5 7E 7
PCB 1248	3 1	1E-6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 4E 1	2 0E 6
PCB 1254	0 35	1E-6	0 20	0 14	3 300	250	25	70	9 125	25 550	2 0E-05	2 0E+00	1 6E 2	2 3E 7
4 4 DDE	4 3	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E-04	3 4E-01	1 7E 3	1 0E 7
4 4 DDT	72	1E-6	0 20	0 03	3 300	250	25	70	9 125	25 550	5 0E-04	3 4E-01	2 8E 2	1 7E-6
Antimony	8 3	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E 04	NTV	0 0E+0	NA
Arsenic	6 0	1E 6	0 20	0 03	3 300	250	25	70	9 125	25 550	3 0E-04	1 5E+00	3 9E 3	6 2E 7
Beryllium	0 73	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	2 0E-03	NTV	0 0E+0	NA
Chromium	24	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E-03	NTV	0 0E+0	NA
Copper	39	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	4 0E-02	NTV	0 0E+0	NA
Lead	68	1E-6	0 20	0	3 300	250	25	70	9 125	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	0 20	0	3 300	250	25	70	9 125	25 550	3 0E-04	NTV	0 0E+0	NA
Benzo(a)anthracene	0 36	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-01	NA	7 9E 8
Benzo(a)pyrene	0 48	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 1E-6
Benzo(b)fluoranthene	0 35	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-01	NA	7 7E 8
Benzo(k)fluoranthene	0 21	1E-6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-02	NA	4 6E 9
Dibenz(a h)anthracene	0 16	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E+00	NA	3 5E 7
Indeno(1 2 3-cd)pyrene	0 25	1E 6	0 20	0 13	3 300	250	25	70	9 125	25 550	NTV	7 3E-01	NA	5 5E 8
												Total	1 9E 1	6 8E-6

Attachment A 34 7
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

$$\text{Equation 1 } \text{HI} = (\text{CS CF IR EF ED}) / (\text{BW AT}_{\text{nc}} \text{ RfD}_{\text{rel}})$$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = (\text{CS CF IR EF ED SF}_{\text{rel}}) / (\text{BW AT})$$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (25 550 days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	5 50E 05	1E 6	100	250	25	70	9 125	25 550	NTV	1 5E+05	NA	2 9E 6
PCB 1248	3 1	1E-6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 5E 1	2 2E 6
PCB 1254	0 35	1E 6	100	250	25	70	9 125	25 550	2 0E 05	2 0E+00	1 7E 2	2 4E 7
4 4 DDE	4 3	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	8 4E 3	5 1E 7
4 4 DDT	72	1E 6	100	250	25	70	9 125	25 550	5 0E 04	3 4E 01	1 4E 1	8 6E 6
Antimony	8 3	1E 6	100	250	25	70	9 125	25 550	4 0E 04	NTV	2 0E 2	NA
Arsenic	6 0	1E 6	100	250	25	70	9 125	25 550	3 0E 04	1 5E+00	2 0E 2	3 1E 6
Beryllium	0 73	1E 6	100	250	25	70	9 125	25 550	2 0E 03	NTV	3 6E 4	NA
Chromium	24	1E 6	100	250	25	70	9 125	25 550	3 0E 03	NTV	7 8E 3	NA
Copper	39	1E 6	100	250	25	70	9 125	25 550	4 0E 02	NTV	9 5E 4	NA
Lead	68	1E 6	100	250	25	70	9 125	25 550	NTV	NTV	NA	NA
Mercury	0 079	1E 6	100	250	25	70	9 125	25 550	3 0E 04	NTV	2 6E 4	NA
Benzo(a)anthracene	0 36	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	9 2E 8
Benzo(a)pyrene	0 48	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	1 2E 6
Benzo(b)fluoranthene	0 35	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	8 9E 8
Benzo(k)fluoranthene	0 21	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 02	NA	5 4E 9
Dibenz(a h)anthracene	0 16	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E+00	NA	4 1E 7
Indeno(1 2 3 cd)pyrene	0 25	1E 6	100	250	25	70	9 125	25 550	NTV	7 3E 01	NA	6 4E 8
										Total	3 7E 1	1 9E 5

Attachment A 34 8
Future Industrial/Commercial Worker
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD	SF	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E 05	1E-6	0 03	0 03	2 000	250	5	70	1 825	25 550	NTV	1 5E+05	NA	6 4E 9
PCB 1248	1 3	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 05	1 0E+00	5 3E 3	7 6E 9
PCB 1254	0 35	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E-05	1 0E+00	1 4E 3	2 1E 9
4 4 DDE	1 6	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	5 0E-04	3 4E-01	2 6E 4	3 2E 9
4 4 DDT	27	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	5 0E-04	3 4E 01	4 4E 3	5 4E 8
Antimony	7 8	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	4 0E-04	NTV	1 6E 3	NA
Arsenic	5 7	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E 04	1 5E+00	1 6E 3	5 0E 8
Beryllium	0 67	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	2 0E 03	NTV	2 8E 5	NA
Chromium	23	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E 03	NTV	6 3E 4	NA
Copper	27	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	4 0E 02	NTV	5 5E 5	NA
Lead	48	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	3 0E 04	NTV	1 6E 5	NA
Benzo(a)anthracene	0 26	1E 6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 1E 9
Benzo(a)pyrene	0 28	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	1 2E 8
Benzo(b)fluoranthene	0 26	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E 01	NA	1 1E 9
Benzo(k)fluoranthene	0 16	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E 02	NA	6 9E 11
Dibenz(a h)anthracene	0 081	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E+00	NA	3 5E 9
Indeno(1 2 3 cd)pyrene	0 19	1E-6	0 03	0 14	2 000	250	5	70	1 825	25 550	NTV	7 3E-01	NA	8 1E 10
												Total	1 5E 2	1 4E 7

Attachment A 34-9
Future Industrial/Commercial Worker
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{rel}) / (BW \cdot AT_{carc})$

Where CR = Cancer Risk (unitless)
 AT_{carc} = Averaging Time for Carcinogens (25 550 days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT _{carc}	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	3.40E-05	1E-6	50	250	5	70	1.825	25.550	NTV	1.5E+05	NA	1.8E 7
PCB 1248	1.3	1E-6	50	250	5	70	1.825	25.550	2.0E-05	1.0E+00	3.2E 2	4.5E 8
PCB 1254	0.35	1E-6	50	250	5	70	1.825	25.550	2.0E-05	1.0E+00	8.6E 3	1.2E 8
4,4 DDE	1.6	1E-6	50	250	5	70	1.825	25.550	5.0E-04	3.4E-01	1.6E 3	1.9E-8
4,4 DDT	27	1E-6	50	250	5	70	1.825	25.550	5.0E-04	3.4E-01	2.6E 2	3.2E 7
Antimony	7.8	1E-6	50	250	5	70	1.825	25.550	4.0E-04	NTV	9.5E 3	NA
Arsenic	5.7	1E-6	50	250	5	70	1.825	25.550	3.0E-04	1.5E+00	9.3E 3	3.0E 7
Beryllium	0.67	1E-6	50	250	5	70	1.825	25.550	2.0E-03	NTV	1.6E 4	NA
Chromium	23	1E-6	50	250	5	70	1.825	25.550	3.0E 03	NTV	3.8E 3	NA
Copper	27	1E-6	50	250	5	70	1.825	25.550	4.0E-02	NTV	3.3E 4	NA
Lead	48	1E-6	50	250	5	70	1.825	25.550	NTV	NTV	NA	NA
Mercury	0.06	1E 6	50	250	5	70	1.825	25.550	3.0E 04	NTV	9.8E 5	NA
Benzo(a)anthracene	0.26	1E-6	50	250	5	70	1.825	25.550	NTV	7.3E 01	NA	6.6E 9
Benzo(a)pyrene	0.28	1E-6	50	250	5	70	1.825	25.550	NTV	7.3E+00	NA	7.1E 8
Benzo(b)fluoranthene	0.26	1E 6	50	250	5	70	1.825	25.550	NTV	7.3E 01	NA	6.6E 9
Benzo(k)fluoranthene	0.16	1E 6	50	250	5	70	1.825	25.550	NTV	7.3E-02	NA	4.1E 10
Dibenz(a,h)anthracene	0.081	1E-6	50	250	5	70	1.825	25.550	NTV	7.3E+00	NA	2.1E 8
Indeno(1,2,3-cd)pyrene	0.19	1E 6	50	250	5	70	1.825	25.550	NTV	7.3E 01	NA	4.8E 9
										Total	9.2E 2	9.9E 7

Attachment A 34 10
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{ref})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{ref} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{ref})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{ref} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD _{ref}	SF _{ref}	Hazard Index	Cancer Risk
Dioxin TEQ	5.50E-05	1E-6	0.3	0.03	3.300	12	30	70	10.950	25.550	NTV	1.5E+05	NA	4.9E-8
PCB 1248	3.1	1E-6	0.3	0.14	3.300	12	30	70	10.950	25.550	2.0E-05	2.0E+00	1.0E-2	1.7E-7
PCB 1254	0.35	1E-6	0.3	0.14	3.300	12	30	70	10.950	25.550	2.0E-05	2.0E+00	1.1E-3	2.0E-8
4,4 DDE	4.3	1E-6	0.3	0.03	3.300	12	30	70	10.950	25.550	5.0E-04	3.4E-01	1.2E-4	8.7E-9
4,4 DDT	72	1E-6	0.3	0.03	3.300	12	30	70	10.950	25.550	5.0E-04	3.4E-01	2.0E-3	1.5E-7
Antimony	8.3	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	4.0E-04	NTV	0.0E+0	NA
Arsenic	6.0	1E-6	0.3	0.03	3.300	12	30	70	10.950	25.550	3.0E-04	1.5E+00	2.8E-4	5.4E-8
Beryllium	0.73	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	2.0E-03	NTV	0.0E+0	NA
Chromium	24	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	3.0E-03	NTV	0.0E+0	NA
Copper	39	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	4.0E-02	NTV	0.0E+0	NA
Lead	68	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	NTV	NTV	NA	NA
Mercury	0.079	1E-6	0.3	0	3.300	12	30	70	10.950	25.550	3.0E-04	NTV	0.0E+0	NA
Benzo(a)anthracene	0.36	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E-01	NA	6.8E-9
Benzo(a)pyrene	0.48	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E+00	NA	9.1E-8
Benzo(b)fluoranthene	0.35	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E-01	NA	6.6E-9
Benzo(k)fluoranthene	0.21	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E-02	NA	4.0E-10
Dibenz(a,h)anthracene	0.16	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E+00	NA	3.0E-8
Indeno(1,2,3-cd)pyrene	0.25	1E-6	0.3	0.13	3.300	12	30	70	10.950	25.550	NTV	7.3E-01	NA	4.7E-9
												Total	1.4E-2	5.9E-7

Attachment A 34-11
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR \cdot EF \cdot ED) / (BW \cdot AT_{nc} \cdot RfD_{oral})$

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot IR \cdot EF \cdot ED \cdot SF_{rel}) / (BW \cdot AT)$

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (25 550 days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT	RfD _{oral}	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	5.50E-05	1E-6	100	12	30	70	10,950	25,550	NTV	1.5E+05	NA	1.7E-7
PCB 1248	3.1	1E-6	100	12	30	70	10,950	25,550	2.0E-05	2.0E+00	7.3E-3	1.2E-7
PCB 1254	0.35	1E-6	100	12	30	70	10,950	25,550	2.0E-05	2.0E+00	8.2E-4	1.4E-8
4,4'-DDE	4.3	1E-6	100	12	30	70	10,950	25,550	5.0E-04	3.4E-01	4.0E-4	2.9E-8
4,4'-DDT	72	1E-6	100	12	30	70	10,950	25,550	5.0E-04	3.4E-01	6.8E-3	4.9E-7
Antimony	8.3	1E-6	100	12	30	70	10,950	25,550	4.0E-04	NTV	9.7E-4	NA
Arsenic	6.0	1E-6	100	12	30	70	10,950	25,550	3.0E-04	1.5E+00	9.4E-4	1.8E-7
Beryllium	0.73	1E-6	100	12	30	70	10,950	25,550	2.0E-03	NTV	1.7E-5	NA
Chromium	24	1E-6	100	12	30	70	10,950	25,550	3.0E-03	NTV	3.8E-4	NA
Copper	39	1E-6	100	12	30	70	10,950	25,550	4.0E-02	NTV	4.6E-5	NA
Lead	68	1E-6	100	12	30	70	10,950	25,550	NTV	NTV	NA	NA
Mercury	0.079	1E-6	100	12	30	70	10,950	25,550	3.0E-04	NTV	1.2E-5	NA
Benzo(a)anthracene	0.36	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E-01	NA	5.3E-9
Benzo(a)pyrene	0.48	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E+00	NA	7.1E-8
Benzo(b)fluoranthene	0.35	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E-01	NA	5.1E-9
Benzo(k)fluoranthene	0.21	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E-02	NA	3.1E-10
Dibenz(a,h)anthracene	0.16	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E+00	NA	2.4E-8
Indeno(1,2,3-cd)pyrene	0.25	1E-6	100	12	30	70	10,950	25,550	NTV	7.3E-01	NA	3.7E-9
Total										1.8E-2	1.1E-6	

Attachment A 34 12
Current Trespasser/Site Visitor
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF AD AB SA EF ED)/(BW AT_{nc} RfD_{oral})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm²)
 AB = Absorbed Fraction (unitless)
 SA = Surface Area of Exposed Skin (cm²/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration (years)
 BW = Body Weight (kg)
 AT_{nc} = Averaging Time for Non Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF AD AB SA EF ED SF_{oral})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	AD	AB	SA	EF	ED	BW	AT _{nc}	AT	RfD	SF	Hazard Index	Cancer Risk
Dioxin TEQ	3.40E-05	1E-6	0.04	0.03	2.000	6	9	70	3.285	25.550	NTV	1.5E+05	NA	3.7E 10
PCB 1248	1.3	1E 6	0.04	0.14	2.000	6	9	70	3.285	25.550	2.0E 05	1.0E+00	1.7E 4	4.4E 10
PCB 1254	0.35	1E-6	0.04	0.14	2.000	6	9	70	3.285	25.550	2.0E-05	1.0E+00	4.6E 5	1.2E 10
4,4 DDE	1.6	1E-6	0.04	0.03	2.000	6	9	70	3.285	25.550	5.0E 04	3.4E-01	1.8E-6	3.9E 11
4,4 DDT	27	1E-6	0.04	0.03	2.000	6	9	70	3.285	25.550	5.0E-04	3.4E-01	3.0E 5	6.7E 10
Antimony	7.8	1E-6	0.04	0	2.000	6	9	70	3.285	25.550	4.0E 04	NTV	0.0E+0	NA
Arsenic	5.7	1E-6	0.04	0.03	2.000	6	9	70	3.285	25.550	3.0E-04	1.5E+00	1.1E 5	6.2E 10
Beryllium	0.67	1E 6	0.04	0	2.000	6	9	70	3.285	25.550	2.0E-03	NTV	0.0E+0	NA
Chromium	23	1E 6	0.04	0	2.000	6	9	70	3.285	25.550	3.0E-03	NTV	0.0E+0	NA
Copper	27	1E-6	0.04	0	2.000	6	9	70	3.285	25.550	4.0E-02	NTV	0.0E+0	NA
Lead	48	1E 6	0.04	0	2.000	6	9	70	3.285	25.550	NTV	NTV	NA	NA
Mercury	0.06	1E 6	0.04	0	2.000	6	9	70	3.285	25.550	3.0E 04	NTV	0.0E+0	NA
Benzo(a)anthracene	0.26	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E 01	NA	6.0E 11
Benzo(a)pyrene	0.28	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	6.4E 10
Benzo(b)fluoranthene	0.26	1E-6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E-01	NA	6.0E 11
Benzo(k)fluoranthene	0.16	1E 6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E 02	NA	3.7E 12
Dibenz(a,h)anthracene	0.081	1E-6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E+00	NA	1.9E 10
Indeno(1,2,3-cd)pyrene	0.19	1E-6	0.04	0.13	2.000	6	9	70	3.285	25.550	NTV	7.3E-01	NA	4.4E 11
												Total	2.6E 4	3.2E 9

Attachment A 34 13
Current Trespasser/Site Visitor
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = (CS CF IR EF ED)/(BW AT_{nc} RfD_{rel})

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1 x10⁻⁶ kg/mg)
 IR = Soil Ingestion Rate for an Adult (mg/day)
 EF = Exposure Frequency (days/year)
 ED = Exposure Duration for an Adult (years)
 BW = Body Weight for an Adult (kg)
 AT = Averaging Time for Non Carcinogens (days)
 RfD_{rel} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = (CS CF IR EF ED SF_{rel})/(BW AT)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (25 550 days)
 SF_{rel} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CS	CF	IR	EF	ED	BW	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	3 40E 05	1E 6	50	6	9	70	3 285	25 550	NTV	1 5E+05	NA	7 7E 9
PCB 1248	1 3	1E 6	50	6	9	70	3 285	25 550	2 0E 05	1 0E+00	7 6E 4	2 0E 9
PCB 1254	0 35	1E 6	50	6	9	70	3 285	25 550	2 0E-05	1 0E+00	2 1E 4	5 3E 10
4 4 DDE	1 6	1E 6	50	6	9	70	3 285	25 550	5 0E-04	3 4E 01	3 8E 5	8 2E 10
4 4 DDT	27	1E 6	50	6	9	70	3 285	25 550	5 0E-04	3 4E 01	6 3E 4	1 4E 8
Antimony	7 8	1E 6	50	6	9	70	3 285	25 550	4 0E-04	NTV	2 3E 4	NA
Arsenic	5 7	1E 6	50	6	9	70	3 285	25 550	3 0E 04	1 5E+00	2 2E 4	1 3E 8
Beryllium	0 67	1E 6	50	6	9	70	3 285	25 550	2 0E 03	NTV	3 9E 6	NA
Chromium	23	1E 6	50	6	9	70	3 285	25 550	3 0E 03	NTV	9 0E 5	NA
Copper	27	1E 6	50	6	9	70	3 285	25 550	4 0E 02	NTV	7 9E 6	NA
Lead	48	1E 6	50	6	9	70	3 285	25 550	NTV	NTV	NA	NA
Mercury	0 06	1E 6	50	6	9	70	3 285	25 550	3 0E 04	NTV	2 3E 6	NA
Benzo(a)anthracene	0 26	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 9E 10
Benzo(a)pyrene	0 28	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	3 1E 9
Benzo(b)fluoranthene	0 26	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 9E 10
Benzo(k)fluoranthene	0 16	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 02	NA	1 8E 11
Dibenz(a h)anthracene	0 081	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E+00	NA	8 9E 10
Indeno(1 2 3 cd)pyrene	0 19	1E 6	50	6	9	70	3 285	25 550	NTV	7 3E 01	NA	2 1E 10
										Total	2 2E 3	4 3E 8

Attachment A 34 14
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI $(CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
 (hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
 CS = Concentration of Chemical in Soil (mg/kg)
 CF = Conversion Factor (1×10^{-6} kg/mg)
 AD = Adherence Factor for Soil (mg/cm³)
 AB = Absorbed Fraction (unitless)
 SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
 SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
 EF = Exposure Frequency (days/year)
 ED_{child} = Exposure Duration for a Child (years)
 ED_{adult} = Exposure Duration for an Adult (years)
 BW_{child} = Body Weight for a Child (kg)
 BW_{adult} = Body Weight for an Adult (kg)
 AT_{nc} = Averaging Time for Non-Carcinogens (days)
 RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR $(CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} \cdot BW_{child}) / (SA_{adult} \cdot ED_{adult} \cdot BW_{adult}))) / (AT_c)$
 (cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
 AT = Averaging Time for Carcinogens (days)
 SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5.50E-05	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	1.5E+05	NA	1.9E-6
PCB 1248	3.1	1E 6	0.3	0.14	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E 05	2.0E+00	0.7961225	6.8E-6
PCB 1254	0.35	1E 6	0.3	0.14	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E 05	2.0E 00	0.0898848	7.6E 7
4,4 DDE	4.3	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	5.0E 04	3.4E 01	0.0094654	3.4E 7
4,4 DDT	72	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	5.0E 04	3.4E 01	0.1584907	5.7E 6
Antimony	8.3	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	4.0E 04	NTV	0	NA
Arsenic	6.0	1E 6	0.3	0.03	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E 04	1.5E 00	0.0220126	2.1E 6
Beryllium	0.73	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	2.0E 03	NTV	0	NA
Chromium	24	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E 03	NTV	0	NA
Copper	39	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	4.0E 02	NTV	0	NA
Lead	68	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	NTV	NA	NA
Mercury	0.079	1E 6	0.3	0	1.913	3.300	350	6	24	15	70	2.190	25.550	3.0E 04	NTV	0	NA
Benzo(a)anthracene	0.36	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 01	NA	2.7E 7
Benzo(a)pyrene	0.48	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 00	NA	3.6E 6
Benzo(b)fluoranthene	0.35	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 01	NA	2.6E 7
Benzo(k)fluoranthene	0.21	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 02	NA	1.6E 8
Dibenz(a,h)anthracene	0.16	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 00	NA	1.2E 6
Indeno(1,2,3-cd)pyrene	0.25	1E 6	0.3	0.13	1.913	3.300	350	6	24	15	70	2.190	25.550	NTV	7.3E 01	NA	1.8E 7
Total															1.1E+0	2.3E 5	

Attachment A 34 15
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Reasonable Maximum Exposure (RME)
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} = Soil Ingestion Rate for a Child (mg/day)
IR_{adult} = Soil Ingestion Rate for an Adult (mg/day)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{oral} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT	AT	RfD _{oral}	SF _{oral}	Hazard Index	Cancer Risk
Dioxin TEQ	5.50E-05	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	1.5E+05	NA	1.3E 5
PCB 1248	3.1	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E 05	2.0E+00	2.0E+0	9.7E 6
PCB 1254	0.35	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E-05	2.0E+00	2.2E 1	1.1E 6
4,4'-DDE	4.3	1E 6	200	100	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	1.1E 1	2.3E 6
4,4'-DDT	72	1E 6	200	100	350	6	24	15	70	2 190	25 550	5.0E 04	3.4E 01	1.8E+0	3.8E 5
Antimony	8.3	1E 6	200	100	350	6	24	15	70	2 190	25 550	4.0E 04	NTV	2.7E 1	NA
Arsenic	6.0	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 04	1.5E 00	2.6E 1	1.4E 5
Beryllium	0.73	1E 6	200	100	350	6	24	15	70	2 190	25 550	2.0E 03	NTV	4.7E 3	NA
Chromium	24	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 03	NTV	1.0E 1	NA
Copper	39	1E 6	200	100	350	6	24	15	70	2 190	25 550	4.0E 02	NTV	1.2E 2	NA
Lead	68	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0.079	1E 6	200	100	350	6	24	15	70	2 190	25 550	3.0E 04	NTV	3.4E 3	NA
Benzo(a)anthracene	0.36	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	4.1E 7
Benzo(a)pyrene	0.48	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	5.5E 6
Benzo(b)fluoranthene	0.35	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	4.0E 7
Benzo(k)fluoranthene	0.21	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 02	NA	2.4E 8
Dibenz(a,h)anthracene	0.16	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E+00	NA	1.8E 6
Indeno(1,2,3 cd)pyrene	0.25	1E 6	200	100	350	6	24	15	70	2 190	25 550	NTV	7.3E 01	NA	2.9E 7
													Total	4.8E+0	8.7E 5

Attachment A-34 16
Hypothetical Future Resident
Estimated Risk for Dermal Contact with Surface Soil
COPCs 0 0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 HI $(CS \cdot CF \cdot AD \cdot AB \cdot SA_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{oral})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
CF = Conversion Factor (1×10^4 kg/mg)
AD = Adherence Factor for Soil (mg/cm²)
AB = Absorbed Fraction (unitless)
SA_{child} = Surface Area of Exposed Skin for a Child (cm²/day)
SA_{adult} = Surface Area of Exposed Skin for an Adult (cm²/day)
EF = Exposure Frequency (days/year)
ED_{child} = Exposure Duration for a Child (years)
ED_{adult} = Exposure Duration for an Adult (years)
BW_{child} = Body Weight for a Child (kg)
BW_{adult} = Body Weight for an Adult (kg)
AT_{nc} = Averaging Time for Non Carcinogens (days)
RfD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR $(CS \cdot CF \cdot AD \cdot AB \cdot EF \cdot SF_{oral} \cdot ((SA_{child} \cdot ED_{child} / BW_{child}) + (SA_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (days)
SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	AD	AB	SA _{child}	SA _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{oral}	SF _{or}	Hazard Index	Cancer Risk
Dioxin TEQ	3.40E-05	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	1.5E-05	NA	5.5E-8
PCB 1248	1.3	1E 6	0.04	0.14	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	3.4E-2	6.6E-8
PCB 1254	0.35	1E 6	0.04	0.14	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	9.0E-3	1.8E-8
4,4 DDE	1.6	1E-6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	3.5E-4	5.9E-9
4,4 DDT	27	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	6.0E-3	1.0E-7
Antimony	7.8	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4.0E-04	NTV	0.0E-0	NA
Arsenic	5.7	1E 6	0.04	0.03	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-04	1.5E-00	2.1E-3	9.3E-8
Beryllium	0.67	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	2.0E-03	NTV	0.0E-0	NA
Chromium	23	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	0.0E-0	NA
Copper	27	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	4.0E-02	NTV	0.0E+0	NA
Lead	48	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0.06	1E 6	0.04	0	1 440	2 000	350	6	3	15	70	2 190	25 550	3.0E-04	NTV	0.0E-0	NA
Benzo(a)anthracene	0.26	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.9E-9
Benzo(a)pyrene	0.28	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-00	NA	9.6E-8
Benzo(b)fluoranthene	0.26	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.9E-9
Benzo(k)fluoranthene	0.16	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-02	NA	5.5E-10
Dibenz(a,h)anthracene	0.081	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-00	NA	2.8E-8
Indeno(1,2,3-cd)pyrene	0.19	1E 6	0.04	0.13	1 440	2 000	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.5E-9
Total															5.1E-2	4.9E-7	

Attachment A 34 17
Hypothetical Future Resident
Estimated Risk for Ingestion of Surface Soil
COPCs 0-0 5 Feet Below Ground Surface (BGS)
Central Tendency Exposure (CTE)
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $HI = (CS \cdot CF \cdot IR_{child} \cdot EF \cdot ED_{child}) / (BW_{child} \cdot AT_{nc} \cdot RfD_{rel})$
(hazard estimate assumes child only exposure)

Where HI = Hazard Index (unitless)
CS = Concentration of Chemical in Soil (mg/kg)
EF = Exposure Frequency (days/year)
ED_{child} Exposure Duration for a Child (years)
ED_{adult} Exposure Duration for an Adult (years)
BW_{child} Body Weight for a Child (kg)
BW_{adult} Body Weight for an Adult (kg)
AT_{nc} Averaging Time for Non Carcinogens (days)
CF = Conversion Factor (1×10^{-6} kg/mg)
IR_{child} Soil Ingestion Rate for a Child (mg/day)
IR_{adult} Soil Ingestion Rate for an Adult (mg/day),
RfD_{rel} Oral Reference Dose (mg/kg/day)

Equation 2 $CR = (CS \cdot CF \cdot EF \cdot SF_{rel} \cdot ((IR_{child} \cdot ED_{child} / BW_{child}) + (IR_{adult} \cdot ED_{adult} / BW_{adult}))) / (AT_c)$
(cancer risk assumes child + adult exposure)

Where CR = Cancer Risk (unitless)
AT = Averaging Time for Carcinogens (25 550 days)
SF_{rel} Oral Cancer Slope Factor (mg/kg/day)

Chemical	CS	CF	IR _{child}	IR _{adult}	EF	ED _{child}	ED _{adult}	BW _{child}	BW _{adult}	AT _{nc}	AT	RfD _{rel}	SF _{rel}	Hazard Index	Cancer Risk
Dioxin TEQ	3.40E-05	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	1.5E+05	NA	2.9E-6
PCB 1248	1.3	1E-6	100	50	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	4.2E-1	7.5E-7
PCB 1254	0.35	1E-6	100	50	350	6	3	15	70	2 190	25 550	2.0E-05	1.0E+00	1.1E-1	2.0E-7
4,4 DDE	1.6	1E-6	100	50	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	2.0E-2	3.1E-7
4,4 DDT	27	1E-6	100	50	350	6	3	15	70	2 190	25 550	5.0E-04	3.4E-01	3.5E-1	5.3E-6
Antimony	7.8	1E-6	100	50	350	6	3	15	70	2 190	25 550	4.0E-04	NTV	1.2E-1	NA
Arsenic	5.7	1E-6	100	50	350	6	3	15	70	2 190	25 550	3.0E-04	1.5E+00	1.2E-1	4.9E-6
Beryllium	0.67	1E-6	100	50	350	6	3	15	70	2 190	25 550	2.0E-03	NTV	2.1E-3	NA
Chromium	23	1E-6	100	50	350	6	3	15	70	2 190	25 550	3.0E-03	NTV	4.9E-2	NA
Copper	27	1E-6	100	50	350	6	3	15	70	2 190	25 550	4.0E-02	NTV	4.3E-3	NA
Lead	48	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	NTV	NA	NA
Mercury	0.06	1E-6	100	50	350	6	3	15	70	2 190	25 550	3.0E-04	NTV	1.3E-3	NA
Benzo(a)anthracene	0.26	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-7
Benzo(a)pyrene	0.28	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-00	NA	1.2E-6
Benzo(b)fluoranthene	0.26	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	1.1E-7
Benzo(k)fluoranthene	0.16	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-02	NA	6.7E-9
Dibenz(a,h)anthracene	0.081	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E+00	NA	3.4E-7
Indeno(1,2,3 cd)pyrene	0.19	1E-6	100	50	350	6	3	15	70	2 190	25 550	NTV	7.3E-01	NA	8.0E-8
										Total	1.2E+0				1.6E-5

Attachment A-34-18
Summary of Cancer Risks and Non-Cancer Hazard Indices
Site-Wide
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

	Hazard Index		Cancer Risk	
	CTE	RME	CTE	RME
Future Excavation/Construction Worker				
Dermal	0 015	0 21	5 7E 9	1 5E 7
Ingestion	0 085	0 48	3 2E 8	3 5E 7
Total	0 10	0 68	3 8E 8	5 0E 7
Future Industrial/Commercial Worker				
Dermal	0 015	0 19	1 4E 7	6 8E 6
Ingestion	0 09	0 37	9 9E 7	1 9E 5
Total	0 11	0 56	1 1E 6	2 6E 5
Current Trespasser/Site Visitor				
Dermal	0 00026	0 014	3 2E 9	5 9E 7
Ingestion	0 0022	0 018	4 3E 8	1 1E 6
Total	0 0025	0 031	4 6E 8	1 7E 6
Hypothetical Future Resident				
Dermal	0 051	1 1	4 9E 7	2 3E 5
Ingestion	1 2	4 8	1 6E 5	8 7E 5
Total	1 2	5 9	1 7E 5	1 1E 4

Attachment A 35.1
 Johnson Ettinger Results for Site-Wide Groundwater
 St Louis Army Ammunition Plant
 St Louis Missouri
 DATA ENTRY SHEET 11 Dichloroethene

GW SCREEN
 Version 3.0, 04/03

**Reset to
 Defaults**

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter X* in YES* box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
 (enter X* in YES box and initial groundwater conc below)

YES

ENTER Chemical CAS No. (numbers only)	ENTER Initial groundwater conc C _w ($\mu\text{g/L}$)	Chemical
75354	3.40E+01	11 Dichloroethylene

MORE

ENTER Depth below ground bottom of closed space floor L _f (cm)	ENTER D pH b low grade to water table L _w (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature T (°C)
200	400	SC	10

ENTER Average apor flow rate at bldg (L/min to calculate) Q_{soil} (L/m)

MORE

ENTER V dose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User defined vadose zone soil vapor permeability K _v (cm^3/s)	ENTER Vadose zone SCS soil type	ENTER V dose zone soil dry bulk density P _b (g/cm^3)	ENTER Vadose zone soil total porosity n (unitless)	ENTER Vadose zone soil water filled porosity θ _w (cm^3/cm^3)
		Lookup Soil Parameters			
	1.00E-08			1.5	0.43
					0.3

MORE

ENTER Target risk for carcinogens TR (unitless)	ENTER Target hazard quotient for noncarcinogens THQ (unitless)	ENTER Ageing time for carcinogens AT (yrs)	ENTER Ageing time for noncarcinogens AT _{NC} (yrs)	ENTER Exposure duration ED (yrs)	ENTER Exposure frequency EF (days/yr)
1.0E-06	1	70	30	30	350
Used to calculate risk based groundwater concentration					

Attachment A 35 1
Johnson Ettinger Results for Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri
RESULTS SHEET 11 Dichloroethene

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Indoor exposure groundwater conc carcinogen ($\mu\text{g/L}$)	Indoor exposure groundwater conc noncarcinogen ($\mu\text{g/L}$)	Risk based indoor exposure groundwater conc ($\mu\text{g/L}$)	Pure component S	Final indoor exposure groundwater conc ($\mu\text{g/L}$)
NA	NA	NA	2.25E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
NA	1.1E 02

MESSAGE SUMMARY BELOW

END

Attachment A 35-2
 Johnson Ettinger Results for Site-Wide Groundwater
 St Louis Army Ammunition Plant (SLAAP)
 St Louis Missouri
 DATA ENTRY SHEET 1 2-D chloroethane

GW SCREEN
 Version 3.0, 04/03

**Reset to
 Defaults**

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter X in YES box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
 (enter X in YES box and input groundwater conc below)

YES

ENTER Chemical CAS N (numbers only dashes)	ENTER Initial grou dw ter co	ENTER Cw (μ g/L)	ENTER Ch mical
107062	4 00E 01	1 2-D chloroethane	

MORE 

ENTER Depth below grade to bottom of enclosed space floor L _f (cm)	ENTER Depth below grade to bottom of enclosed space floor L _w (cm)	ENTER SCS soil type w t r t b l e	ENTER Average soil/goundwater temperature T (°C)
200	400	SC	10

ENTER Average vapor flow rate into bldg (Leave blank to calculate) Q _v (L/m)
5

MORE 

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability) p rm ability	ENTER User defined vadose zone soil apor permeability K _v (cm^2)	ENTER Vadose zone SCS soil typ Lookup Soil Parameters	ENTER Vadose zone oil dry bulk density P _b (g/cm^3)	ENTER Vadose zone soil total porosity n (itless)	ENTER Vadose zone soil water filled porosity θ _w (m^3/cm^3)
		1.00E-08		1.5	0.43
					0.3

MORE 

ENTER Target hazard quotient for carcinogens TR (itless)	ENTER Ageing time for carcinogens THQ (itless)	ENTER Average aging time for carcinogens AT (yrs)	ENTER Average aging time for carcinogens AT _{NC} (yrs)	ENTER Exposure duration ED (yrs)	ENTER Exposure frequency EF (days/y)
1.0E 08	1	70	30	30	360
Used to calc late risk-based groundwater concent n					

Attachment A 35 2
 Johnson Ettinger Results for Site-Wide Groundwater
 St Louis Army Ammunition Plant (SLAAP)
 St Louis Missouri
 RESULTS SHEET 1 2 Dichloroethane

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Indoor exposure groundwater carcinogen conc ($\mu\text{g/L}$)	Indoor exposure groundwater noncarcinogen conc ($\mu\text{g/L}$)	Risk based indoor exposure groundwater conc ($\mu\text{g/L}$)	Pure water solubility S ($\mu\text{g/L}$)	Final indoor exposure groundwater conc ($\mu\text{g/L}$)
NA	NA	NA	8 52E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen conc (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen conc (unitless)
1 4E 08	NA

MESSAGE SUMMARY BELOW

END

Attachment A 35-3
 Johnson Ettinger Results for Site-Wide Groundwater
 St Louis Army Ammunition Plant (SLAAP)
 St Louis Missouri
 DATA ENTRY SHEET Carbon Tetrachloride

GW SCREEN
 Version 3.0, 04/03

CALCULATE RISK BASED GROUNDWATER CONCENTRATION (enter X in YES box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION
 (enter X in YES box and input groundwater conc below)

YES

ENTER Chemical CAS No (numbers only dashes)	ENTER Inital groundwater conc C _w ($\mu\text{g/L}$)	Chemical
56235	1.00E 00	Carbon tetrachloride

MORE

ENTER Depth below grade to bottom of enclosed space floor L _f (cm)	ENTER Depth below grade to water table L _{wr} (cm)	ENTER SCS soil type d rectly above water table	ENTER Average soil/groundwater temperature T (°C)	ENTER Average vapo flow rate to bldg (Leak blankt calculate) Q _{av} (L/m)
200	400	SC	10	5

MORE

ENTER Vadose zone SCS soil type (soil to estimate soil por permability)	ENTER Use defined andos zone soil porosity k _s (cm^3/s)	ENTER Vadose zone SCS soil type L _{lkup} Soil Parameters	ENTER V dose zone soil dry bulk density ρ _b (g/cm^3)	ENTER Vadose zone oil total porosity n (nittless)	ENTER Vadose zone soil w/ filled porosity θ _w (cm^3/m^3)	
	1.00E-08			1.5	0.43	0.3

MORE

ENTER Target risk to carbon tetrachloride TR (nittless)	ENTER Target hazard quotient for carbon tetrachloride THQ (nittless)	ENTER Averaging time for carbon tetrachloride AT (yrs)	ENTER Averaging time for carbon tetrachloride AT _{HC} (yrs)	ENTER Exposure duration ED (yrs)	ENTER Exposure frequency EF (days/yr)
1.0E 06	1	70	30	30	350
Used to calculate risk based groundwater concentration					

Attachment 35 3
Johnson Ettinger REsults for Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri
RESULTS SHEET Carbon Tetrachloride

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Indoor exposure groundwater conc carcinogen ($\mu\text{g/L}$)	Indoor exposure groundwater conc noncarcinogen ($\mu\text{g/L}$)	Risk based indoor exposure groundwater conc ($\mu\text{g/L}$)	Pure water solubility S	Final indoor exposure groundwater conc ($\mu\text{g/L}$)
NA	NA	NA	7.93E+05	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
3.7E-07	NA

MESSAGE SUMMARY BELOW

END

Table A 35-4
 Johnson Ettinger Results for Site-Wide Groundwater
 St Louis Army Ammunition Plant (SLAAP)
 St Louis Missouri
 DATA ENTRY SHEET Chloroform

GW SCREEN Version 3.0, 04/03		CALCULATE RISK BASED GROUNDWATER CONCENTRATION (ent X in YES box)					
		YES <input type="checkbox"/>					
Reset to Defaults		OR					
		CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter X in YES box and initial groundwater conc below)					
		YES <input checked="" type="checkbox"/>					
ENTER Ch mical CAS No (numbers only no dashes)		ENTER Initial groundwater concentration C_w ($\mu\text{g/L}$)		ENTER Ch mical			
67683		1.00E 01		Chloroform			
ENTER Depth below grade to bott m of e clos d space floo L _f (cm)		ENTER Depth below grade to water t ble L _w (cm)		ENTER SCS soil type directly above water table		ENTER Average soil/ groundwater temperat re T (°C)	
200		400		SC		10	
MORE ▼						ENTER Ave ag vapor flow atel to bldg (Leave blank to calculate) Q_{av} (L/m)	
						5	
MORE ▼		ENTER Vadose z SCS soil typ (ed to estim t soil apo permeabilty)		ENTER User defined vadose zone oil apor pe meability K_v (cm^3)		ENTER Vadose zon SCS oil typ	
		OR		L _v up Soil Parameters		ENTER V dose zo e oil dry bulk density ρ_b (g/cm^3)	
						ENTER Vadose zone oil total porosity θ_w (nittess)	
		1.00E 08				ENTER V dose z oil w t fill d porosity θ_w (cm^3/cm^3)	
MORE ▼		ENTER Target hazard q uot ent to oncancr TR (unless)		ENTER Ageing time f carciog ns		ENTER Averagl g time fo no carcinogens	
		THQ (unless)		AT (yrs)		AT _{NC} (yrs)	
						Expos r d ton ED (yrs)	
						Expos e f q ency EF (days/y)	
1.0E 06		1		70		30	
						30	
						350	
Us dt calc l t rnsk based gou dw te co ce t t							

Attachment A 35 4
Johnson Ettinger Results for Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri
RESULTS SHEET Chloroform

RISK BASED GROUNDWATER CONCENTRATION CALCULATIONS

Indoor exposure groundwater conc carcinogen ($\mu\text{g/L}$)	Indoor exposure groundwater conc noncarcinogen ($\mu\text{g/L}$)	Risk based indoor exposure groundwater conc ($\mu\text{g/L}$)	Pure water solubility S	Final indoor exposure groundwater conc ($\mu\text{g/L}$)
NA	NA	NA	7 92E+06	NA

INCREMENTAL RISK CALCULATIONS

Incremental risk from vapor intrusion to indoor air carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air noncarcinogen (unitless)
1 0E 06	NA

MESSAGE SUMMARY BELOW

END

Attachment A-36-1
Summary of COPCs, Exposure Point Concentrations and Toxicity Values
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis , Missouri

Chemical	units	Maximum Detect	Monitoring Well Location	Frequency of Detection	Permeability Constant ^a (cm/hr)	Subchronic RfD _o ^b (mg/kg day)	Subchronic RfD _i ^{b,c} (mg/kg day)	SF _o (mg/kg day) ¹	SF _i (mg/kg day) ¹
1,2 Diphenylhydrazine	mg/L	3.5E 4	08MW 01	2/13	1.3E 2	NTV	NA	8.0E 1	NA
Benzo(a)anthracene	mg/L	6.6E 5	08MW 02	13/13	4.7E 1	NTV	NA	7.3E 1	NA
Benzo(a)pyrene	mg/L	9.2E 5	08MW 02	13/13	7.0E 1	NTV	NA	7.3E+0	NA
Benzo(b)fluoranthene	mg/L	9.9E 5	08MW 02	13/13	7.0E 1	NTV	NA	7.3E 1	NA
Benzo(k)fluoranthene	mg/L	1.9E 4	08MW 02	13/13	7.0E 1	NTV	NA	7.3E 2	NA
Chrysene	mg/L	1.3E 4	08MW 02	13/13	4.7E 1	NTV	NA	7.3E 3	NA
Dibenz(a,h)anthracene	mg/L	7.7E 5	08MW 02	13/13	1.5E+0	NTV	NA	7.3E+0	NA
Indeno(1,2,3 cd)pyrene	mg/L	1.1E 4	08MW 02	9/13	1.0E+0	NTV	NA	7.3E 1	NA
Arsenic	mg/L	7.8E 3	08MW 01	13/13	1.0E 3	3.0E 4	NA	1.5E+0	NA
1,1 Dichloroethene	mg/L	3.4E 2	02MW 01	1/13	1.2E 2	5.0E 2	5.7E 2	NTV	NTV
1,2 Dichloroethane	mg/L	4.0E 4	02MW 01	1/13	4.2E 3	3.0E 2	1.4E 3	9.1E 2	9.1E 2
Carbon tetrachloride	mg/L	1.0E 3	02MW 01	1/13	1.6E 2	7.0E 4	7.0E 4	1.3E 1	5.3E 2
Chloroform	mg/L	1.0E 2	02MW 01	1/13	6.8E 3	1.0E 2	8.6E 4	NTV	NTV

NTV No toxicity value

NA Not applicable

For evaluation of site wide groundwater the maximum detected concentration was used as the exposure point concentration for both RME and CTE

^a Permeability constants for organic compounds from RAGS Part E Exhibit B 3 arsenic based on PC for water

^b Chronic values were used if no subchronic values were available

^c Oral RfD values were used for evaluating inhalation of carbon tetrachloride and chloroform

Attachment A-36-2
Future Excavation/Construction Worker
Estimated Risk for Incidental Ingestion of Shallow Groundwater
Reasonable Maximum Exposure (RME)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1} \quad \text{HI} = ((\text{CW IR EF ED}) / (\text{BW AT}_{nc})) \left(1 / R_f D_{\text{oral}} \right)$$

Where HI = Hazard Index (unitless)

CW = Concentration of Chemical in Water (mg/L)

IR = Water Ingestion Rate (L/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2} \quad \text{CR} = ((\text{CW} * \text{IR} * \text{EF} * \text{ED}) / (\text{AT}_c * \text{BW})) \text{ SF}_{\text{oral}}$$

Where - CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	HI	CR
1,2-Diphenylhydrazine	3.5E 4	0.002	60	1	70	84	25 550	NTV	8.0E 1	0.0E+0	1.9E 11
Benzo(a)anthracene	6.6E 5	0.002	60	1	70	84	25 550	NTV	7.3E 1	0.0E+0	3.2E 12
Benzo(a)pyrene	9.2E 5	0.002	60	1	70	84	25 550	NTV	7.3E+0	0.0E+0	4.5E 11
Benzo(b)fluoranthene	9.9E 5	0.002	60	1	70	84	25 550	NTV	7.3E 1	0.0E+0	4.8E 12
Benzo(k)fluoranthene	1.9E 4	0.002	60	1	70	84	25 550	NTV	7.3E 2	0.0E+0	9.3E 13
Chrysene	1.3E 4	0.002	60	1	70	84	25 550	NTV	7.3E 3	0.0E+0	6.4E 14
Dibenz(a,h)anthracene	7.7E 5	0.002	60	1	70	84	25 550	NTV	7.3E+0	0.0E+0	3.8E 11
Indeno(1,2,3-cd)pyrene	1.1E 4	0.002	60	1	70	84	25 550	NTV	7.3E 1	0.0E+0	5.4E 12
Arsenic	7.8E 3	0.002	60	1	70	84	25 550	3.0E 4	1.5E+0	5.3E 4	7.9E 10
1,1-Dichloroethene	3.4E 2	0.002	60	1	70	84	25 550	5.0E 2	NTV	1.4E 5	0.0E+0
1,2-Dichloroethane	4.0E 4	0.002	60	1	70	84	25 550	3.0E 2	9.1E 2	2.7E 7	2.4E 12
Carbon tetrachloride	1.0E 3	0.002	60	1	70	84	25 550	7.0E 4	1.3E 1	2.9E 5	8.7E 12
Chloroform	1.0E 2	0.002	60	1	70	84	25 550	1.0E 2	NTV	2.0E 5	0.0E+0
Total											5.9E 4
Total											9.1E 10

Attachment A-36-3
Future Excavation/Construction Worker
Estimated Risk for Incidental Ingestion of Shallow Groundwater
Central Tendency Exposure (CTE)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 HI = ((CW IR EF ED)/(BW AT_{nc})) (1/R_fD_{oral})

Where HI = Hazard Index (unitless)

CW = Concentration of Chemical in Water (mg/L)

IR = Water Ingestion Rate (L/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)

R_fD_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 CR = ((CW IR EF ED)/(AT_c BW)) SF_{oral}

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	IR	EF	ED	BW	AT _{nc}	AT _c	RfD _{oral}	SF _{oral}	HI	CR
1,2 Diphenylhydrazine	3.5E 4	0.001	30	1	70	42	25 550	NTV	8.0E 1	0.0E+0	4.7E 12
Benzo(a)anthracene	6.6E 5	0.001	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	8.1E 13
Benzo(a)pyrene	9.2E 5	0.001	30	1	70	42	25 550	NTV	7.3E+0	0.0E+0	1.1E 11
Benzo(b)fluoranthene	9.9E 5	0.001	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	1.2E 12
Benzo(k)fluoranthene	1.9E 4	0.001	30	1	70	42	25 550	NTV	7.3E 2	0.0E+0	2.3E 13
Chrysene	1.3E 4	0.001	30	1	70	42	25 550	NTV	7.3E 3	0.0E+0	1.6E 14
Dibenz(a,h)anthracene	7.7E 5	0.001	30	1	70	42	25 550	NTV	7.3E+0	0.0E+0	9.4E 12
Indeno(1,2,3 cd)pyrene	1.1E 4	0.001	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	1.3E 12
Arsenic	7.8E 3	0.001	30	1	70	42	25 550	3.0E 4	1.5E+0	2.7E 4	2.0E 10
1,1 Dichloroethene	3.4E 2	0.001	30	1	70	42	25 550	5.0E 2	NTV	6.9E 6	0.0E+0
1,2 Dichloroethane	4.0E 4	0.001	30	1	70	42	25 550	3.0E 2	9.1E 2	1.4E 7	6.1E 13
Carbon tetrachloride	1.0E 3	0.001	30	1	70	42	25 550	7.0E 4	1.3E 1	1.5E 5	2.2E 12
Chloroform	1.0E 2	0.001	30	1	70	42	25 550	1.0E 2	NTV	1.0E 5	0.0E+0
									Total	3.0E 4	2.3E 10

Attachment A 36 4
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Shallow Groundwater
Reasonable Maximum Exposure (RME)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $HI = ((CW \cdot CF \cdot PC \cdot ET \cdot SA \cdot EF \cdot ED) / (AT_c \cdot BW)) \cdot (1/R_{fD_{oral}})$

Where HI = Hazard Index (unitless)

CW = Concentration of Chemical in Water (mg/L)

CF = Conversion Factor (L/cm³)

PC = Permeability Constant (cm/hr)

ET = Exposure Time (hr/day)

SA = Surface Area of Exposed Skin (cm²)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)

R_{fD}_{oral} = Oral Reference Dose (mg/kg/day)

Equation 2 $CR = ((CW \cdot CF \cdot PC \cdot ET \cdot SA \cdot EF \cdot ED) / (AT_c \cdot BW)) \cdot SF_{oral}$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	CF	PC	ET	SA	EF	ED	BW	AT _c	AT _c	R _{fD} _{oral}	SF _{oral}	HI	CR
1,2-Diphenylhydrazine	3.5E 4	0.001	1.3E 2	4	3300	60	1	70	84	25550	NTV	8.0E 1	0.0E+0	1.6E 9
Benzo(a)anthracene	6.6E 5	0.001	4.7E 1	4	3300	60	1	70	84	25550	NTV	7.3E 1	0.0E+0	1.0E 8
Benzo(a)pyrene	9.2E 5	0.001	7.0E 1	4	3300	60	1	70	84	25550	NTV	7.3E+0	0.0E+0	2.1E 7
Benzo(b)fluoranthene	9.9E 5	0.001	7.0E 1	4	3300	60	1	70	84	25550	NTV	7.3E 1	0.0E+0	2.2E 8
Benzo(k)fluoranthene	1.9E 4	0.001	7.0E 1	4	3300	60	1	70	84	25550	NTV	7.3E 2	0.0E+0	4.3E 9
Chrysene	1.3E 4	0.001	4.7E 1	4	3300	60	1	70	84	25550	NTV	7.3E 3	0.0E+0	2.0E 10
Dibenz(a,h)anthracene	7.7E 5	0.001	1.5E+0	4	3300	60	1	70	84	25550	NTV	7.3E+0	0.0E+0	3.7E 7
Indeno(1,2,3-cd)pyrene	1.1E 4	0.001	1.0E+0	4	3300	60	1	70	84	25550	NTV	7.3E 1	0.0E+0	3.6E 8
Arsenic	7.8E 3	0.001	1.0E 3	4	3300	60	1	70	84	25550	3.0E 4	1.5E+0	3.5E 3	5.2E 9
1,1-Dichloroethene	3.4E 2	0.001	1.2E 2	4	3300	60	1	70	84	25550	5.0E 2	NTV	1.1E 3	0.0E+0
1,2-Dichloroethane	4.0E 4	0.001	4.2E 3	4	3300	60	1	70	84	25550	3.0E 2	9.1E 2	7.5E 6	6.8E 11
Carbon tetrachloride	1.0E 3	0.001	1.6E 2	4	3300	60	1	70	84	25550	7.0E 4	1.3E 1	3.1E 3	9.2E 10
Chloroform	1.0E 2	0.001	6.8E 3	4	3300	60	1	70	84	25550	1.0E 2	NTV	9.2E 4	0.0E+0
Total												8.6E 3	6.6E 7	

Attachment A 36 5
Future Excavation/Construction Worker
Estimated Risk for Dermal Contact with Shallow Groundwater
Central Tendency Exposure (CTE)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

$$\text{Equation 1 } \text{HI} = ((\text{CW CF PC ET SA EF ED}) / (\text{AT}_{nc} \text{ BW})) (1/\text{R}_f\text{D}_{o \text{ ai}})$$

Where HI = Hazard Index (unitless)

CW = Concentration of Chemical in Water (mg/L)

CF = Conversion Factor (L/cm³)

PC = Permeability Constant (cm/hr)

ET = Exposure Time (hr/day)

SA = Surface Area of Exposed Skin (cm²)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens ((365 days/year) ED)

R_fD_{o ai} = Oral Reference Dose (mg/kg/day)

$$\text{Equation 2 } \text{CR} = ((\text{CW CF PC ET SA EF ED}) / (\text{AT}_c \text{ BW})) \text{ SF}_{oral}$$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{oral} = Oral Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	CF	PC	ET	SA	EF	ED	BW	AT _{nc}	AT _c	R _f D _{oral}	SF _{oral}	HI	CR
1,2 Diphenylhydrazine	3.5E 4	0 001	1.3E 2	2	200	30	1	70	42	25 550	NTV	8.0E 1	0.0E+0	2.4E 11
Benzo(a)anthracene	6.6E 5	0 001	4.7E 1	2	200	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	1.5E 10
Benzo(a)pyrene	9.2E 5	0 001	7.0E 1	2	200	30	1	70	42	25 550	NTV	7.3E+0	0.0E+0	3.2E 9
Benzo(b)fluoranthene	9.9E 5	0 001	7.0E 1	2	200	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	3.4E 10
Benzo(k)fluoranthene	1.9E 4	0 001	7.0E 1	2	200	30	1	70	42	25 550	NTV	7.3E 2	0.0E+0	6.5E 11
Chrysene	1.3E 4	0 001	4.7E 1	2	200	30	1	70	42	25 550	NTV	7.3E 3	0.0E+0	3.0E 12
Dibenz(a,h)anthracene	7.7E 5	0 001	1.5E+0	2	200	30	1	70	42	25 550	NTV	7.3E+0	0.0E+0	5.7E 9
Indeno(1,2,3 cd)pyrene	1.1E 4	0 001	1.0E+0	2	200	30	1	70	42	25 550	NTV	7.3E 1	0.0E+0	5.4E 10
Arsenic	7.8E 3	0 001	1.0E 3	2	200	30	1	70	42	25 550	3.0E 4	1.5E+0	1.1E 4	7.9E 11
1,1 Dichloroethene	3.4E 2	0 001	1.2E 2	2	200	30	1	70	42	25 550	5.0E 2	NTV	3.3E 5	0.0E+0
1,2 Dichloroethane	4.0E 4	0 001	4.2E 3	2	200	30	1	70	42	25 550	3.0E 2	9.1E 2	2.3E 7	1.0E 12
Carbon tetrachloride	1.0E 3	0 001	1.6E 2	2	200	30	1	70	42	25 550	7.0E 4	1.3E 1	9.3E 5	1.4E 11
Chloroform	1.0E 2	0 001	6.8E 3	2	200	30	1	70	42	25 550	1.0E 2	NTV	2.8E 5	0.0E+0
												Total	2.6E 4	1.0E 8

Attachment A 36 6
Future Excavation/Construction Worker
Estimated Risk for Inhalation of Volatilized Groundwater COPCs
Reasonable Maximum Exposure (RME)
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Equation 1 $VF_{oc} = k_{LG}/(kNH)$

where

VF_{oc} = volatilization factor of volatile organic compound

k_{LG} = Aqueous mass transfer coefficient from the liquid phase to gas phase

for VOC of interest (m/sec)

k = Mixing factor to account for incomplete air exchange in trench (unitless)

N = Number of air exchanges per unit time in the trench (sec⁻¹)

H = Height of the trench (m)

assuming

$k_{LG} = 3 \times 10^{-6}$ m/sec (conservative estimate of mass transfer coefficient for VOC's from groundwater to air USEPA 1999)

Equation 2 $N = v/L$

where

v = wind speed (m/sec)

L = length of trench (m)

Equation 3 $C_v = CW \cdot VF_{oc} \cdot CF$

where

C_{air} = Concentration of the chemical in the vapor phase (mg/m³)

CW = Concentration of the chemical in the water phase (mg/L)

CF = Conversion Factor (L/m³)

Equation 4 $HI = C_{air} EF ED IR_{af} ET/(AT_{nc} BW RfD_{inh})$

Where HI = Hazard Index (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

IR = Inhalation Rate (m³/hr)

ET = Exposure Time (hr/day)

BW = Body Weight (kg)

AT_c = Averaging Time for Non Carcinogens (days)

R_fD_{inh} = Inhalation Reference Dose (mg/kg/day)

Equation 5 $CR = C_{air} EF ED IR_a ET SF_{inh}/(AT_c BW)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{inh} = Inhalation Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	K_{LG}	k	H	L	v	N	VF_{oc}	CF	C_{air}	EF	ED	ET	IR	BW	AT _{nc}	AT _c	R _f D _{inh}	SF _{inh}	HI	CR
1,1-Dichloroethene	3.4E-2	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1E+3	4.5E-4	60	1	4	2.05	70	84	25.550	5.7E-2	NTV	6.7E-4	0.0E+0
1,2-Dichloroethane	4.0E-4	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1E+3	5.3E-6	60	1	4	2.05	70	84	25.550	1.4E-3	9.1E-2	3.2E-4	1.3E-10
Carbon tetrachloride	1.0E-3	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1E+3	1.3E-5	60	1	4	2.05	70	84	25.550	7.0E-4	5.3E-2	1.6E-3	1.9E-10
Chloroform	1.0E-2	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1E+3	1.3E-4	60	1	4	2.05	70	84	25.550	8.6E-4	NTV	1.3E-2	0.0E+0
Total																				1.6E-2	3.3E-10

Attachment A 36 7

Future Excavation/Construction Worker
Estimated Risk for Inhalation of Volatilized Groundwater COPCs
Central Tendency Exposure (CTE)
Site Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis Missouri

Equation 1 $VF_{oc} = k_{LG}/(kNH)$

where

VF_{oc} = volatilization factor of volatile organic compound

k_{LG} = Aqueous mass transfer coefficient from the liquid phase to gas phase

for VOC of interest (m/sec)

k = Mixing factor to account for incomplete air exchange in trench (unitless)

N = Number of air exchanges per unit time in the trench (sec⁻¹)

H = Height of the trench (m)

assuming

$k_{LG} = 3 \times 10^{-6}$ m/sec (conservative estimate of mass transfer coefficient for VOCs from groundwater to air USEPA 1999)

Equation 2 $N = v/L$

where

v = wind speed (m/sec)

L = length of trench (m)

Equation 3 $C_v = CW \cdot VF_{oc} \cdot CF$

where

C_v = Concentration of the chemical in the vapor phase (mg/m³)

CW = Concentration of the chemical in the water phase (mg/L)

CF = Conversion Factor (L/m³)

Equation 4 $HI = C_{av} \cdot EF \cdot ED \cdot IH \cdot ET / (AT_{nc} \cdot BW \cdot RfD_{I,h})$

Where HI = Hazard Index (unitless)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

IH = Inhalation Rate (m³/hr)

ET = Exposure Time (hr/day)

BW = Body Weight (kg)

AT_{nc} = Averaging Time for Non Carcinogens (days)

$RfD_{I,h}$ = Inhalation Reference Dose (mg/kg/day)

Equation 5 $CR = C_{av} \cdot EF \cdot ED \cdot IH \cdot ET \cdot SF_{inh} / (AT_c \cdot BW)$

Where CR = Cancer Risk (unitless)

AT_c = Averaging Time for Carcinogens (25 550 days)

SF_{inh} = Inhalation Cancer Slope Factor (mg/kg/day)¹

Chemical	CW	K_{LG}	k	H	L	v	N	VF_{oc}	CF	C_{av}	EF	ED	ET	IH	BW	AT_{nc}	AT_c	$RfD_{I,h}$	SF_{inh}	HI	CR
1,1-Dichloroethene	3.4E-2	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1.0E+3	4.5E-4	30	1	2	1.3	70	42	25.550	5.7E-2	NTV	2.1E-4	0.0E+0
1,2-Dichloroethane	4.0E-4	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1.0E+3	5.3E-6	30	1	2	1.3	70	42	25.550	1.4E-3	9.1E-2	1.0E-4	2.1E-11
Carbon tetrachloride	1.0E-3	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1.0E+3	1.3E-5	30	1	2	1.3	70	42	25.550	7.0E-4	5.3E-2	5.1E-4	3.1E-11
Chloroform	1.0E-2	3E-6	0.5	3	30	4.5	0.15	1.3E-5	1.0E+3	1.3E-4	30	1	2	1.3	70	42	25.550	8.6E-4	NTV	4.1E-3	0.0E+0
Total																			4.9E-3	5.2E-11	

Attachment A-36-8
Summary of Cancer Risks and Non-Cancer Hazard Indices
Site-Wide Groundwater
St Louis Army Ammunition Plant (SLAAP)
St Louis, Missouri

Hazard Index		Cancer Risk	
CTE	RME	CTE	RME
Future Excavation/Construction Worker			
Dermal	0 0003	0 0086	1 0E 8
Ingestion	0 00030	0 00059	2 3E 10
Inhalation	0 0049	0 016	5 2E 11
Total	<u>0 0055</u>	<u>0 025</u>	<u>1 0E 8</u>
			<u>6 6E 7</u>

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